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THE DRAINAGE PLANS FOR CHICAGO have been again modified by the Drainage Canal Trustees, who now advocate a channel 10 ft. deep. This, they claim, will accommodate all the vessels that will pass through the Illinois River to Chicago, and save $25,000,000. This depth, they say, will also dilute the sewage as much as is necessary.

THE CAR STOVE MUST GO IN MASSACHUSETTS if the legislature passes a bill recently reported by the State Railroad Committee. It provides that it shall be unlawful for any steam railway operating in the state after Nov. 1, 1892, to heat its passenger cars by a stove or furnace inside the car or suspended from it, unless such method of heating becomes temporarily necessary by reason of accident. The Commissioners may, however, grant exemptions from these requirements when they deem such action necessary. The penalty for violating the provisions of the proposed law is a fine not exceeding $500.

THE NUMBER OF COMPOUND LOCOMOTIVES in use or in process of construction has increased between Nov. 1, 1889, and Nov. 1, 1890, from 580 to 1,034, according to a statement by Herr VON BORRIES in the *Engineer*. The total number is divided as follows: Germany, 430; England, including those built for South America and India, 523; Italy, 2; Russia, 32; Switzerland, 11; North America, 8; street railways, 28.

A LARGE SHUTTER DAM, similar to the one built at Davis Island and described in ENGINEERING NEWS of May 15, 1886, will be built at Vanport, Pa., under the direction of Col. W. E. MERRILL, U. S. A., who has had charge of the Ohio River improvements for several years.

THE COST of PUBLIC IMPROVEMENTS of Omaha, Neb., up to the end of 1890, included $3,660,131 for 61.2 miles of paving and $1,341,958 for 84.83 miles of sewers. The work for 1890 amounted to $1,091,084, including $508,072 for 217,334 sq. yds. of paving, $124,000 for 64,015 ft. of sewers, $135,336 for City Hall, and $21,613 for expenses of the Engineering Department. The paving prices averaged about as follows: asphalt, $2.54 per sq. yd.; Colorado sandstone, $2.56; granite, $2.25; brick, $1.92; cedar block, $1.37.

THE STAND-PIPE of the water-works at Defiance, O., gave way on March 29. It was of wrought iron, 22x140 ft., and stood on a stone foundation. The reports state that the lower part of the pipe, to a height of about 50 ft., was torn into several pieces and hurled in various directions, one large piece striking the side of the pump-house, about 100 ft. away, and crushing in the side of the building. No satisfactory explanation for the wreck has yet been given.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment on the dummy line at Ensley City, Ala., about 5 miles from that city. The train was running rapidly to make up lost time when it left the rails and went down a 10-ft. bank. Two persons were killed and about 14 injured, some seriously. The accident was evidently due to a bad track. A head collision occurred March 27 between a passenger and an accommodation train at Wells Bridge, N. Y., on the Delaware & Hudson road. Two men were killed. The wreck caught fire and several cars were burned. A rear collision between a passenger and freight train occurred in a tunnel near Ronceverte, W. Va., on the Chesapeake & Ohio Ry. Several persons were slightly injured. The passenger cars caught fire and were all burned. On March 29 four Pullman sleeping cars and a passenger car on a Pennsylvania R. R. express train were derailed and partly upset while the train was running near Devon, Pa. Nobody was seriously injured. It is reported that the ties were found to be in bad condition. On March 27 the locomotive of a Philadelphia & Reading R. R. freight train jumped the track near Barry, Pa., and went down the bank with 32 cars.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: The pontoon bridge across the Missouri River at St. Charles, Mo., was carried away by an accumulation of drift wood March 29. A trestle on the Santa Fé road, near Farmersville, Tex., gave way under a freight train March 24. Two men were killed and several cars wrecked. A highway bridge over the Merrimac River, at Concord, N. H., has been washed away. The Belt Line bridge, at Des Moines, Ia., has been carried away by a flood.

A TIME SCHEDULE FOR LABOR CHARGES in making bills for car repairs has been recommended by the Western Railway Club as an amendment to the Rules of Interchange. The rules already provide that the rate of charge for labor shall be 20 cts. per hour. The proposed schedule is as follows:

Repair.	Hours.
One draft sill	36
Two draft sills	42
Two intermediate sills	30
One intermediate and one draft sill	41
Two intermediate and two draft sills	47
One intermediate sill	15
One side or intermediate sill spliced	18
One end sill	12
One draft timber	7
Two draft timbers	10
One cross tie timber	5
One end post	6
Two end posts	8
One corner or side post	5
One swing bolster	5
One swing plank	4
One end plate	6
One draft iron	1
One door stop side	1
Two cts. per sq. ft. for all sheathing, lining and roofing.	
One ct. per sq. ft. for flooring.	

AN INCLINED PLANE CABLE RAILWAY is being built at Bristol, England, to afford easy access between districts at the top and bottom of cliffs about 240 ft. high. The line will be in tunnel, about 500 ft. long, with a grade of 1 in 2.182 (45.83 %), and a total rise of 230 ft. The tunnel will be 27 ft. wide and 17 ft. high, in solid rock without lining. It will have three ventilating shafts, and be lighted by incandescent lamps. The up and down cars will be attached to the same cable, the down car being made the heavier by filling a tank with water, so that it will haul up the other car. Brakes gripping the rails will have to be held out of gear by the conductor during the trip, as they are applied automatically. An independent brake is applied in case of the rail breaking. A speed governor is also to be provided. Mr. G. C. MARKS and Mr. PHILIP MUNRO are the engineers. Several cable railways on this plan are in use in Switzerland. In England there are three other inclined plane railways, as follows: Lynton, 900 ft. long, with a grade 1 in 1.73 (57.8 %); Scarborough, 1 in 2.50 %, and Folkestone, 1 in 2.10 (47.6 %).

AN IMPROVED DRAINAGE SYSTEM FOR LONDON is the subject of a recent report to the County Council by Sir BENJAMIN BAKER and Mr. ALEX. R. BINNIE. They find that the present outlets are insufficient and recommend three more with a total capacity of 82,000 cu. ft. per minute. The new system provides for a rainfall of ⅜-in. per 24 hours over 60 sq. miles of drainage area and will cost about $12,500,000 The report indirectly recommends the purification of the crude sewage and its discharge into the Thames River, rather than the construction of long outfall sewers to the sea.

THE PRESENT CONDITION OF SIAM is discussed in much detail in a paper by Mr. ROBERT GORDON, M. Inst. C. E.; Am. Soc. C. E., before the Society of Arts, and published in the March issue of its *Journal*. The wealth and trade of the country has been increasing rapidly within the last 20 years, and numerous public improvements in the way of harbor, canal, water and railway works are being actively urged, and are in part under way. These various projects are so numerous that we cannot attempt to even list them, but it is probable that the next 20 years will see a great advance in that country.

THE GREATEST GOLD NUGGETS ever found in Victoria, Australia, are illustrated by a colored plate in a recent number of the *Australian Mining Standard*. Twenty-three nuggets are illustrated, weighing from 24 oz. to 2,280 oz. The latter specimen was nearly pure gold, and its total value at the Bank of England was £9,534 ($46,240). Nearly all the large nuggets were found in the early days of the mining industry.

THE NICARAGUA CANAL excursion party, which sailed from New York by the steamer *Aguan*, on March 14, and among whose members were President WARNER MILLER, and Mr. D. MCN. STAUFFER, of this journal, has met with disaster on its voyage. A cable dispatch from Nicaragua states that the *Aguan* was stranded March 26, on Roncador reef, a small island in the Caribbean Sea, about 300 miles north, west of Greytown. The passengers are reported all safe. The *Carazo*, a steamer running along the Nicaragua coast in connection with the Morgan line of steamships, and the U. S. steamer *Petrel*, which was lying at Greytown, have gone to their assistance.

THE MANCHESTER SHIP CANAL will not be completed within the time or for the amount originally estimated. The company has applied to the corporation of Manchester for financial assistance, its own borrowing powers under the act of incorporation being exhausted, and a report on the matter has been prepared by a committee appointed by the city. The committee has made careful investigations, and has considered reports submitted by its own engineers and by the canal officials. Up to the end of 1890 over $45,000,000 had been spent, while about $20,000,000 more are required, making a total of $65,000,000, against the original estimate of $46,000,000. Unless substantial assistance is promptly given, the works must stop, as the present funds will only last for a few months, and the company has been unable to get the public to subscribe for $2,000,000 of debentures. Any such stoppage, the committee states, will be disastrous, and will probably permanently interfere with the success of the enterprise. It is not thought that the difficulties arise from any innate defect of the project, or that they indicate that the anticipations formed as to its success were unfounded. On the contrary, the committee is not aware of any circumstances that would give rise to apprehension as to the probable earning power of the canal. The committee has therefore recommended that the corporation should secure borrowing powers for $15,000,000, and advance $12,500,000 to the canal company at once. The canal was to have been completed by 1890, but two years more will yet be required.

The Steam-Jet as a Means of Preventing Smoke from Boiler Furnaces.

The city of Chicago is now engaged in an energetic and praiseworthy attempt to abate the smoke nuisance, which is such a grave drawback on its attractions; and it is hoped that the task may be accomplished before the opening of the Columbian Exposition in 1893. A system of smoke prevention

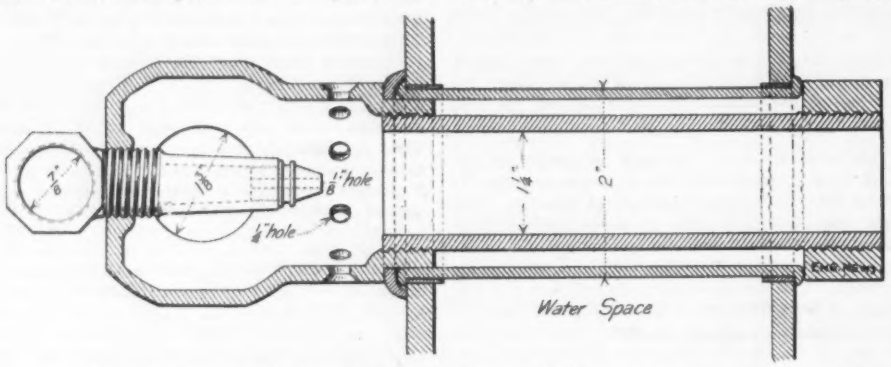


FIG. 1. HUTCHINSON'S STEAM-JET APPARATUS AS APPLIED TO A LOCOMOTIVE FIRE-BOX. SCALE, ½.

which seems to have found much favor with the City Smoke Inspector, and which has been applied on a very considerable number of locomotives and stationary boilers (over 5,000, according to the manufacturer), is known as the "Hutchinson Water Gas Furnace." This device is merely an arrangement for blowing air into the furnace by means of small steam jets. It was formerly known as the "Hutchinson Smoke Consumer," and its name seems to have been changed merely to keep it up with the times, as the "water gas" produced or consumed by it exists, in all probability, only in the imagination of the inventor.

The device, however, seems to have more or less merit in preventing smoke when the furnace is in charge of a careful fireman. As applied to a locomotive, it consists merely of a ¾-in. pipe, taking live steam from the boiler and conducting it to six steam jets which inject air into the firebox through hollow staybolts made of 1¼-in. pipe. Three of these jets are in the front of the fire-box and three in the back beneath the furnace door. A pipe also runs to the front of the engine and opens into the exhaust nozzle, thus avoiding the blowing out of smoke and gas at the furnace door which would otherwise occur when the engine is standing. The jets in the back of the firebox are placed about 4 ins. higher than those in the front, and the current from the former prevents pieces of coal and cinders from being blown out of the firebox door by the force of the jets in the front.

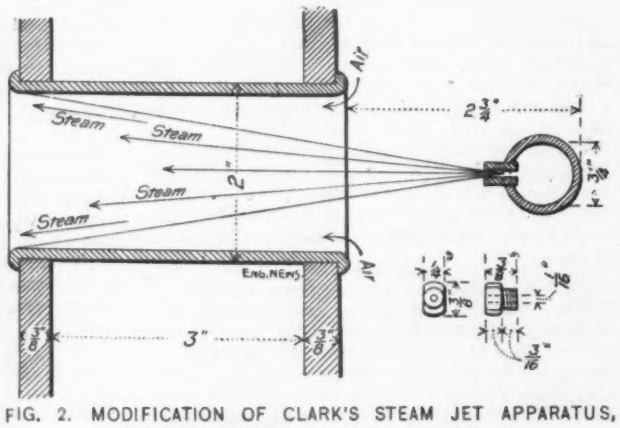


FIG. 2. MODIFICATION OF CLARK'S STEAM JET APPARATUS, USED ON A WESTERN RAILWAY. SCALE, ½.

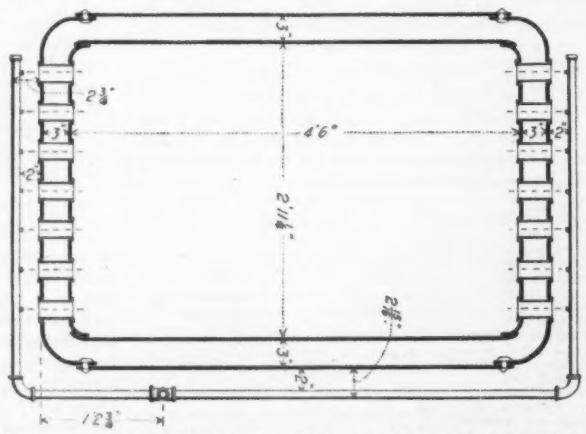


FIG. 3. PLAN OF FIRE-BOX FITTED WITH JETS SHOWN IN FIG. 2.

The only features in which this device seems to differ from other appliances for blowing in air above the fire by a steam jet are shown in the accompanying illustration, Fig. 1, which shows a section of one of the steam jets with the air tube passing through the water-space of a firebox. Just what the advantage is of this peculiar form of construction we are unable to find out. Perhaps it is to get more air into the furnace for a given amount of steam; but the inventor would hardly claim this, since this would diminish the amount of "water gas" in the furnace.

The total cost of the apparatus applied to a locomotive is given as $200, which seems a pretty stiff price, unless more can be shown in favor of its actual working in practice than has as yet come to our knowledge. All the parts are made of malleable iron, except the small nipple with the ⅛-in. hole through which the steam-jet passes, which is made of brass.

For the prevention of smoke, it seems, from all the information we can obtain, that the device has considerable efficiency, provided the firing is carefully done. Not that it will completely prevent the formation of smoke with all trains and all engines; but that a fireman who tries intelligently to so look after his locomotive as to keep black smoke from rolling out of the stack will find the task facilitated by this device. The jets create a pressure above the fire when the locomotive is standing, so that little air is drawn through the grate. As a rule the jets are only used when the engine is standing, or when running and not working steam.

Some very careful tests of this device were made by Mr. JACOB JOHANN on the Wabash, St. Louis & Pacific, about eight years ago, and were reported by him to the Master Mechanics' Association in June, 1884. The tests consisted of runs of six days with an engine in regular passenger service, first with the "Hutchinson Smoke Consumer," and afterward for several days with the same engine in the same service without the device. Mr. JOHANN said of the device:

> As far as the consumption of the smoke and finer cinders is concerned, there can be no doubt but that it is accomplished to a certain extent, but it requires judicious firing. . . . . With our light trains the smoke can be consumed to a great extent; but with our heavy trains, when the engine is working hard, the smoke rolls out in spite of the most careful manipulation.

Very extravagant claims are made as to the fuel economy secured by the use of the Hutchinson jet. Mr. JOHANN's experiments, however, showed a loss in this respect instead of a gain. The figures were as follows:

	With plain firebox.	With Hutchinson steam jets in firebox.
Train miles per ton of coal.....	30.74	30.65
Lbs. moved, 100 miles per lb. of coal	62.43	69.36
Water evaporated per lb. of coal.	5.19	5.09

The apparent better record of the engine with the Hutchinson jets in total weight moved a given distance per lb. of coal is due to the fact that the trains were heavier when that device was in use. Over 1,700 pyrometer readings were taken of the temperature in the smokebox, and the average temperature was found to be 825° when the Hutchinson device was in use and 882°, or 57° higher, when it was not in use.

As is well known, the use of a steam jet to inject air into steam-boiler furnaces is an old idea. Mr. D. K. CLARK was among the early advocates of the system, and many modifications of the device which he used have been put in service. Figs. 2 and 3 show an arrangement of the Clark steam-jet in use on some switching locomotives on a prominent Western road. A ¾-in. pipe runs around the front and rear of the firebox, and 2-in. pipes replace the third row of staybolts from the bottom. Opposite each one of these openings a small brass screw plug, with a $\frac{1}{16}$-in. hole through the center, is screwed into the steam pipe. A smaller number of jets than is shown in the drawing is generally sufficient. The same road has also some engines in use fitted with the Hutchinson jets, and we are informed that one device is as efficient as the other in preventing smoke, so far as can be seen. It need hardly be said that the cost of the system illustrated in Figs. 2 and 3 is far below the cost of the Hutchinson system.

Another modification of the Clark system devised by Mr. WM. BUCHANAN, of the New York Central & Hudson River R. R., and largely used by him, is shown in Figs. 4 and 5. In this system a cone is placed in the water-space tube as shown. The jet of steam and air impinges against the apex of this cone and enters the firebox in an annular jet, so that it is more thoroughly mixed with the furnace gas than a solid jet would be.

MR. BUCHANAN informs us that he uses these steam jets on all passenger locomotives, and finds that with careful and intelligent firing they are efficient in preventing smoke. It will be noticed that the steam is superheated before it reaches the jets by passing through a pipe coil located in "a cool corner of the firebox, just back of the manhole in the water-table. This probably considerably increases its velocity and also diminishes its cooling effect upon the fire. By a simple arrangement, a water circulation is established through the superheating coil whenever the jets are shut off, preventing it from burning out. A three-way cock is placed in the steam-pipe just below the superheater and a pipe from the cock-body is tapped into the water space. When the handle of this cock is in the position shown by full lines, the cock is open for the steam jets. When it is turned to the position shown by dotted lines, the steam jets are shut off and a passage is open for water circulation through the superheater. If desired the superheating coil may be located in the smokebox instead of in the position shown.

An addition to the water table, which may not be familiar to many of our readers, is shown in Fig. 4. Four tubes run through the water space, from the front and back and from the sides of the firebox, admitting air to the furnace gases as they pass up through the manhole. If a larger amount of air is needed from these flues than the blast would draw in, steam jets may be placed to blow air into them.

As for the general principle of injecting air into a furnace by a steam jet, while something may doubtless be gained in the way of smoke prevention, it seems unreasonable to expect very much. If smoke proceeds from a scanty air supply, of course it helps matters to admit air above the grates; but this can be and generally is done without the aid of steam jets. The latter give a greater supply of air from a given area of orifice, and by blowing it in at high velocity tend to mix it more thoroughly with the furnace gases. They may thus be of considerable aid to a careful and intelligent fireman. On the other hand, the cooling effect of the steam jet upon the firebox is much greater than the cooling effect of air

currents admitted through hollow staybolts without a steam jet. The quantity of air supplied is generally much greater with the jets, and the steam itself has a specific heat of .475, and requires about 840 H. U. per lb. of steam admitted to become heated to the temperature of the furnace, calling this 2,000°.

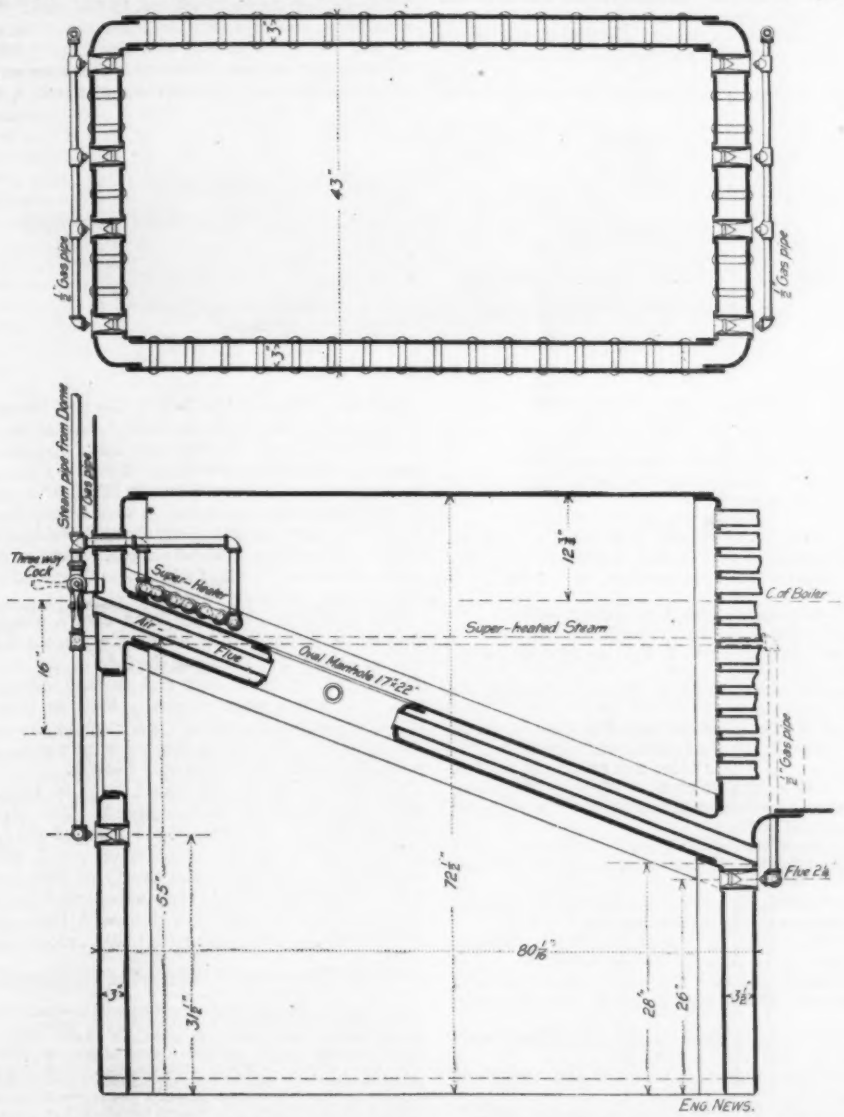


FIG. 4. BUCHANAN'S STEAM JET APPARATUS AS USED WITH WATER-TABLE FIRE-BOX FOR PASSENGER LOCOMOTIVES, NEW YORK CENTRAL & HUDSON RIVER R. R.

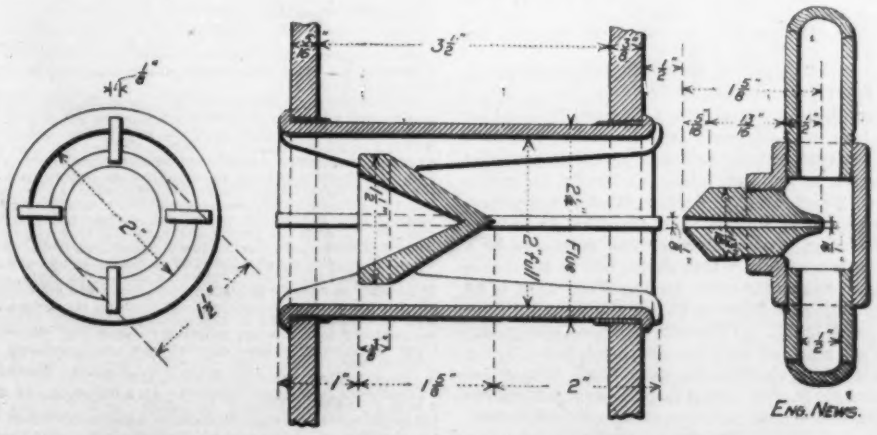


FIG. 5. DETAILS OF BUCHANAN'S STEAM JET APPARATUS. SCALE, ½.

Hence, whenever the smoke is due to the cooling of the firebox by a considerable charge of fresh fuel, it is difficult to see how the steam jet can do anything but make matters worse.

With regard to economy of fuel, careful trials of steam jet blowers have, so far as we know, shown a loss instead of a gain. The reason for this is partly the loss of heat by the escaping steam, which passes up the chimney with the furnace gases and at the same temperature, and partly the excess of air which enters the firebox over that utilized for combustion, compared with that which enters when no steam jets are used. Both the steam and air, so far as the latter is not used for combustion, extract heat from the furnace gases, and all the heat which they carry up the chimney is of course lost.

The heat lost by the air excess is, of course, very variable. The heat lost by the steam jets., can be quite closely calculated. If we suppose 100 lbs. pressure in the pipe supplying the jets, the theoretical flow of steam from an orifice in the pipe will be at a velocity of 902.5 ft. per second, by BROWNLEE'S formula, $V = 3.5953\sqrt{h}$, in which V = the velocity of outflow in feet per second as for steam at the initial density, and h = the height in feet of a column of steam of the given absolute initial pressure of uniform density, the weight of which is equal to the pressure of the steam on a unit area equal to the cross-section of the column.

Since steam at this density weighs 0.2628 lbs. per cu. ft., and the number of cubic feet discharged per second from an orifice 1 sq. in. in area is 902.5 ÷ 144 = 6.267, the weight of steam discharged per minute from such an orifice will be 6.267 × 0.2628 × 60 = 92.8 lbs. The combined area of six $\frac{1}{16}$-in. orifices is 0.0736 sq. in. Hence the total theoretical flow of steam per minute from these orifices will be 92.8 × 0.0736 = 6.83 lbs., or 409.8 lbs. per hour. The actual flow would probably be somewhat less than this, on account of the friction of the jet in passing through such small orifices; but on the other hand the pressure at the orifice which we have assumed, 100 lbs. per sq. in., would probably be exceeded on most locomotives. Taking 410 lbs. per hour as the steam used by the jets, and 12,000 lbs. per hour as the total steam made by the boiler, it appears that nearly 3½% of the total steam made is required to operate the steam jets, to which is to be added the loss of heat involved in heating this steam and the induced currents of air which it carries with it, up to the firebox temperature.

Undoubtedly it is in many cases beneficial to blow air into a boiler furnace above the grates, and a steam jet is generally the handiest means of doing this. Its economy in first cost, however, may easily be overbalanced by an unnoticed increase in fuel consumption; and if power is at hand to run a blower, it will generally be found that this is the cheaper plan for stationary boilers. For locomotives it has generally been found that all the air needed above the grates could be furnished through hollow staybolts without the aid of a jet, when the engine is working steam and creating a draft. When the engine is standing still some arrangement of steam jets is doubtless of value in keeping down smoke.

It may be said in this connection that theory indicates that an advantage, both for economy and for efficiency in smoke prevention, can be gained by heating the air before admitting it above the grates. Practical difficulties, however, have prevented this being done, so far as we know, except in an experimental way. Perhaps some bright engineer may yet find a large field of usefulness for the steam jet in an apparatus which will overcome these difficulties and make it practicable to inject air at a temperature of 500° or more over the fire.

Artesian Well Practice in the Western United States.

(*Continued from p. 305*).

IV.

OTHER COLORADO BASINS.

In our last issue the artesian wells of the Denver basin in Colorado were discussed at some length. The Greeley, Pueblo and Florence districts were referred to in ENGINEERING NEWS for Feb. 21.

The San Luis Valley is outside of the area investigated, but has so large a number of wells as to warrant a notice. The valley extends about 90 miles from north to south, and 45 from east to west. The number of wells is said to be at least 2,000, and by some is placed as high as 5,000. Most of them have a bore of 2 or 3 ins., and many of but 1¼ ins. The two largest wells are at Alamosa, 6 ins. in diameter. One, the first sunk, is owned by C. BUCHER. It is nearly 1,000 ft. deep, with an estimated flow of 140 galls. per minute. It cost $2,750. The second well was sunk by the town to a depth of 835 ft., and has an estimated flow of about 1,000 galls. per minute.

The San Luis wells are mostly shallow, it being common to strike two or three successive flows near the surface. The first flow is frequently sulphurous, and the wells are generally sunk to the second or third water bearing strata.

TEXAS.

A general idea of the artesian wells of Texas can best be given by quoting from the report of Mr. F. E. ROESLER, as follows:

West of the 97th meridian there are, in all, between 650 and 700 flowing wells, ranging in flow from 1 to 1,000 galls. per minute, and in depth from 15 to 1,852 ft., and in cost from $25 to $7,200. The greatest number of flowing wells

are situate in the Counties of Bosque, Somervell, Tarrant and Hood, and in these the average depth is from 200 to 500 ft., a few exceeding this depth. The average flow is between 10 and 20 galls. per minute, a limited number reaching 60 to 100 galls., a few exceeding this, and some reaching a flow of 300 galls. per minute. The largest wells in the State are those at Waco, five of which jointly flow about 5,000,000 galls. per diem. All of the flowing wells except 31 are east of the 100th meridian, and, as a factor in irrigation at present, count for little or nothing. Good palatable water is found at comparatively shallow depth only east of the 99th meridian, and north of a line drawn, say, from the southwest corner of Bandera County to Aransas Pass. South of this line and west of the 99th meridian as far as the 100th meridian, all the flowing water obtained from wells is impregnated with salt, coal oil, gas, and various compounds of soda, sulphur, gypsum, and is generally unfit for irrigation or any other purpose. The wells east of the 99th meridian are in material that a non-geologist would locate as underlying the coal measures, while the mineral wells are in the coal measures and partake of all the evil smells and flavors that these strata afford. As a rule good water (flowing wells) can be obtained anywhere east and north of the coal measures at a depth not exceeding 1,000 ft. A flow of 10 to 100 galls. per minute can be obtained at from 200 to 500 ft., with an increase of flow as the depth is increased. South of the line from Bandera County to Aransas Pass, and west of the 99th meridian, flowing water is found at a depth of 500 to 1,600 ft., but bad water is encountered at 50 to 100 ft., and does not appear to improve at greater depth, though the well-borers and others claim to a man that there is good water in the last deposit of water that was struck in nearly every well that I examined. I confidently believe that there is much truth in the assertion, knowing that until within the past two or three years there was not an apparatus in the state that was adapted for deep borings, and that most of the men were new in the well-boring business, and that a majority of failures were due to inexperience and the improper tools used.

West of the 100th meridian as far as the Pecos River, in what might be called the "semi-arid region," there are a few flowing wells, none of which are over 150 ft. deep, and all of which were found accidentally. There are three in Hockley County, and one each in Dallam, Lubbock and Midland Counties. The flow from any of them is insignificant, except that in Midland County, and this well is more of a spring or underground stream than a well, presenting a feature not common to the rest of the county.

In the arid region, west of the Pecos River, in Reeves County, there are 26 flowing wells. Twenty-four wells are at Pecos City, varying in depth from 185 ft. to 300 ft., and in flow from 20 galls. to 300 galls. per minute. Twenty-two miles west of there, at Toyah Station, are two flowing wells, one of which is 832 ft. deep. The flow from this well is 300 galls. per minute. The water contains sulphur, but judging from the appearance of a five-acre garden irrigated from it, the water is beneficial rather than otherwise to plant life.

COST OF WELLS IN COLORADO AND TEXAS.

The cost of several wells of different sizes in the Denver basin, Colorado, is given below, the size of the well, depth, total cost and cost per lineal foot being stated. The figures are as follows:

Size.	Depth, ft.	Cost.	Cost per ft.	Size.	Depth, ft.	Cost.	Cost per ft.
6.....	322	$800	$2.77	4.....	525	$1,500	$2.85
5⅝....	620	2,500	4.03	3½....	460	900	1.96
5½....	385	1,050	2.73	3.....	314	675	2.14
5⅜....	530	1,500	2.83	3.....	375	1,000	2.67
4½....	500	2,500	5.00	3	416	900	2 13
4.....	270	415	1.54	3.....	425	1,200	2.82
4.....	290	510	1.74	2½....	278	25	.90
4.....	300	1,000	3.33				
4.....	360	800	2 23	Total	6,776	$18,427	
4.....	406	927	2.38	Ave....	399	$1,084	$2.72

The range in cost is from $5 for a 4½-in. well 500 ft. deep to 90cts. for a 2½-in. well 278 ft. deep. Size and depth have but little apparent influence upon the cost, but it must be remembered that the character of the material pierced and the method of sinking are not stated, and are important elements in determining cost.

Fortunately, in Mr. ROESLER'S report the prices per foot for well boring in several Texas counties is given in connection with other particulars. These prices are given below, slightly rearranged for convenience, as follows:

Archer Co.—Drilling, $1.50; casing, 60 cts.; 6 in. casing, 500 ft.

Atascosa Co.—Horse power rigs, $1 first 100 ft., $1.50 second 100 ft.; all sizes of bores.

Bexar Co.—One dollar and fifty cts. first 100, $2 second 100, $2.50 third 100, $3 fourth 100, $3.50 fifth 100 ft.

Bosque Co.—Seventy-five cts. first 100, 50 cts. additional for every additional 100 ft.; $1.50 for first 100, $2 for next 200 ft., $2.50 for balance; 6-in. wells, 525, 600, and 800 ft. Morgan: Generally $1 per ft., 6-in. bore, 500 ft.

Burnet Co.—Oakalla: $1 per ft., 6-in. bore, 100 ft.

Coleman Co.—Trickham: $1 per ft., 6-in. bore.

Coryell Co.—King: $1 per ft., 6-in. bore, 240 ft. Pecan Grove: 75 cts. first 100 ft., $1 second 100 ft.; $20 for 26 ft. 6-in. bore.

Dallam Co.—Tascosa: About $1 per ft.

DeWitt Co.—Yorktown: $2 per ft., including tubing and casing.

Dimmit Co.—Carrizo Springs: $1 first 100 ft., 50 cts. additional for every additional 50 ft.

El Paso Co.—Torbert: $4 per ft., first 500 ft.; $6.50 per ft. next 500 ft., both 8-in. bore; third 500 ft. $9 per ft., 5-in. bore.

Erath Co.—Bluff Dale: $1 for first 100 ft., 25 cts. additional for each additional 100 ft.; 150 to 500 ft.; 75 cts. for first 100 ft., $1 for next 100; 165 ft.

Frio Co.—One dollar first 150 ft., $1.25 next 100 ft., 25 cts. additional every 50 ft; 3 to 6-in. bores; 390 ft.

Glasscock Co.—Garden City: Dug wells 4 or 5 ft. diameter. 25 ft. deep, $2 per ft.

Gonzales Co.—Rancho: $1 to $2.50 at finish; 130 ft.

Grayson Co.—Pottsborough: $1.50 first 100 ft.; $2 for balance; 250 ft., cost with casting, $3 per ft.

Hardeman Co.—Sixty cts. per foot, 10-in. wells, 100 ft. deep.

Hockley Co.—Six-in. bore. 200 ft., at $1.50 per ft.

Hood Co.—Paluxy: $1 per ft., 236 ft.

Jack Co.—Jacksborough: 75 cts. first 100 ft., $1 for second 100 ft., 6-in. bores.

Johnson Co.—Cleburne: $1 for first 100 ft., then $3, and lastly $5 per ft.

Lubbock Co.—Suiger Store: 5 and 6-in. bores. $1 per ft. for the first 100 ft. and 50 cts. rising with each 100 ft.

McLennan Co.—Waco: $2 for first 1,500 ft., $3 next 100 ft., $4 next 100 ft., $5 next 100 ft.

Palo Pinto Co.—Gordon: $1 first 100 ft., 25 cts. per ft. for each additional 100 ft.

Parker Co.—Weatherford: 75 cts. per ft., 440 ft.

Pecos Co.—Dryden: general price, $2 per ft., without casing.

Potter Co.—Amarilla: $1 for the first 100 ft. and 50 cts. per ft. additional for each following 100 ft.

Reeves Co.—Pecos City: $1.50 first 100 ft.; $2 per ft. second 100 ft. Same price for different bores.

Robertson Co.—Calvert: $1.25 to 50 ft., $1.50 next 50 ft., $1.75 next 50 ft., $2 next 50 ft., $2.50 next 50 ft.; 6 in. pipe, 286 ft.

Somervell Co.—Glen Rose: 75 cts. per ft. first 100 ft., adding 25 cts. per ft. for next 100 ft.

Stephens Co.—Wayland: 50 cts. per ft. first 50 ft., 25 cts. per ft. additional for each 50 ft.

Tarrant Co.—Fort Worth: 50 cts. for the first 100 ft.

Taylor Co.—Merkel: Well dug 10 × 10 ft., 70 ft., $8 per ft.; boring, $1 per ft.

Uvalde Co.—A flowing well 102 ft. deep cost $125.

Val Verde Co.—Del Rio: 6-in bore, $1.50, $2, $2.50, rising with each 100 ft. 50 cts. per ft., 300 ft.

Webb Co.—Cactus: $1 per ft. first 100 ft., $2 per ft. the next 70 ft.

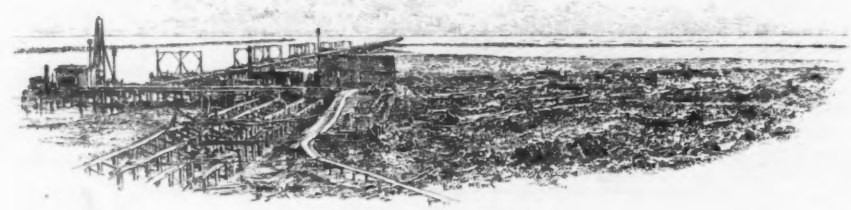
Wise Co.—Hoggsett: $1 per ft. 6 in. well; $1.50 per ft. 8-in.; $2 per ft. 10-in. wells; 198 ft.

As will be seen, the figures are generally based on a 6-in bore, while in every case the variation is with the depth rather than the diameter of hole, provided the latter is not over 6 ins. Generally the prices vary with each 100 ft. in depth. Most of the prices, so far as can be judged from the data, do not include casing. One dollar per foot seems to be a common price for the first 100 ft., but as a notable exception to this the price for the Waco wells is $2 for the first 1,500 ft., with $1 per ft. added for each additional 100 ft. At Torbett, El Paso County, the prices are much above those elsewhere, being $4 for the first 500 ft., $6.50 for the next 500 ft., then $9 for the third 500 ft., but in this case the bore is 8 ins. for 1,000 ft., then 5 ins.

The Brazos River Jetties.

The accompanying cut, from a photograph sent us by Mr. GEO. Y. WISNER, Chief Engineer of the Brazos River Channel & Dock Co., shows the condition of the jetties at the mouth of the Brazos River on Dec. 13, 1890. At that time the total length of the jetties was 5,400 ft., the clear width between them being 560 ft. The depth of water at their outer end was 19 ft., and from 26 to 33 ft. in the channel between them. At the time the photograph was taken, the volume of discharge of the river was 60,000 cu. ft. per second at high water and 30,000 cu. ft. at a medium stage. The velocity of the current at the flood stage is 10 ft. per second, and the amount of sediment carried then averages 4 oz. per cu. ft.

The dry bar shown in the cut, to the right of the west jetty, was originally the inner crest of the bar during low water season, and was usually about 3 ft. below the surface. This bar is now a permanent shore line, and connects with the west jetty 3,200 ft.



BRAZOS RIVER JETTIES.

below the inner end of the jetties. The pool formed by this new shore line was from 3 to 16 ft. deep at the time the jetty was built, but has since silted up until it is now dry at times of low tide. The view shows the outer portion of the pool partially filled with water.

Beyond this new shore line is a bar formed by the material scoured from the jetty channel during a flood in May, 1890. Over 1,000,000 cu. yds. were excavated at that time, nearly all of which was deposited west and south of the jetty entrance.

The spur dikes, or wing dams, shown along the interior of the jetty walls, are for the purpose of producing a deposit of silt along the face of the jetties to render them impervious and prevent undermining. The jetties were originally built in 13 to 16 ft. of water, but the deposit produced by the wing dams has been such that the depth now along the jetties between the dams is only 2 to 4 ft.

The remains of an old wharf, built in 13 ft. of water, are shown in the foreground. The deposit produced by the wing dam at the head of the jetty now extends over 100 ft. outside of the wharf. To the east of the jetties the drift is nearly all Gulf material. This accumulates in the angle formed by jetty and shore, and has built up a high sand beach, concave to Gulf, and extending out 1,200 ft. along jetty.

Legal Decisions of Interest to Engineers.

Liability of City for Defective Sidewalks.—In an action to recover damages for injuries received on account of an alleged defect in a sidewalk against a city or town, the plaintiff must allege and prove that such street or sidewalk upon which the injury occurred was, at the time and place where the injury was sustained, controlled and treated by the town authorities as a public street or sidewalk, and opened as such. In an action if the plaintiff seeks to prove that the city authorized and directed the property owner to construct the sidewalk at the point where the injury occurred in front of his premises, the records of the city council are the best evidence as to what its action was, unless no such record was made as required by law; and parol evidence should not be received as to such action when said record books are accessible and can be produced. If the evidence discloses that the defect in the sidewalk was the remote, and not the proximate, cause of said injury, the plaintiff is not entitled to recover. (Cheldrey v. City of Huntington, Supr. Co. App., W. Va., 12 S. E. Rep., 536.)

Contributory Negligence at Railroad Crossing.—Failure to ring a bell, or to blow a whistle, on an engine, as required by section 61, C. 54, Code 1887, is negligence for which a railroad company is chargeable; but this does not excuse a traveler on a highway crossing a railroad track from the exercise of such reasonable care and caution as the law requires, to ascertain whether a train is approaching the crossing. The traveler and the company have mutual and reciprocal duties and obligations in such case, and, though the train has the right of way, the same degree of care and diligence to avoid collision is due from both. It is the duty of a traveler on the highway crossing a railroad to look carefully for an approaching train, and if looking leaves any doubt, or the view is obstructed, he must listen also before attempting to cross; otherwise, he will himself be guilty of negligence, which will prevent his recovery for an injury received in crossing. Obstructions rendering the view obscure and unreliable call for greater caution on his part. (Beyel v. Newport News & M. V. Ry. Co., Supr. Co. App. W. Va., 12 S. E. Rep., 532.)

Limiting Liability of Carriers.—In a bill of lading for a bull, a provision limiting the liability of the carrier to $30 is not valid, and the shipper may recover according to the measure of damages fixed by laws. (St. Louis, A. & T. Ry. Co. v. Robbins, Ct. of App. Tex., 14 S. W. Rep., 1075.)

Railroad Depots at Intersections.—Under the Texas constitution every railroad company has the right to intersect any other railroad, and make it the duty of each to receive the other passengers and freight subject to "such regulations as shall be prescribed by law." And it is the duty of a railroad company to maintain a depot at its intersection with another railroad, excepting at intersections adjacent to towns where union depots are established. The maintenance of separate depots by two intersecting roads in a town about ¼ mile distant from the points of the intersection is not a substantial compliance with the law. (San Antonio & A. P. Ry. Co. v. State, Supr. Ct. of Tex., 14 S. W. Rep., 1053.)

European Experience with Traction Engines.

At a recent meeting of the Institution of Civil Engineers a paper was read by Mr. JNO. MCLAREN entitled "Steam on Common Roads," giving an excellent summary of the present state of the art. The paper is practically devoted to discussion of the present status of traction-engine manufacture and use, in which the author has been engaged for some years, the early history of steam locomotion on common roads, which was so well described by Mr. JOHN HEAD'S paper read before the Institution 18 years ago, being passed over.

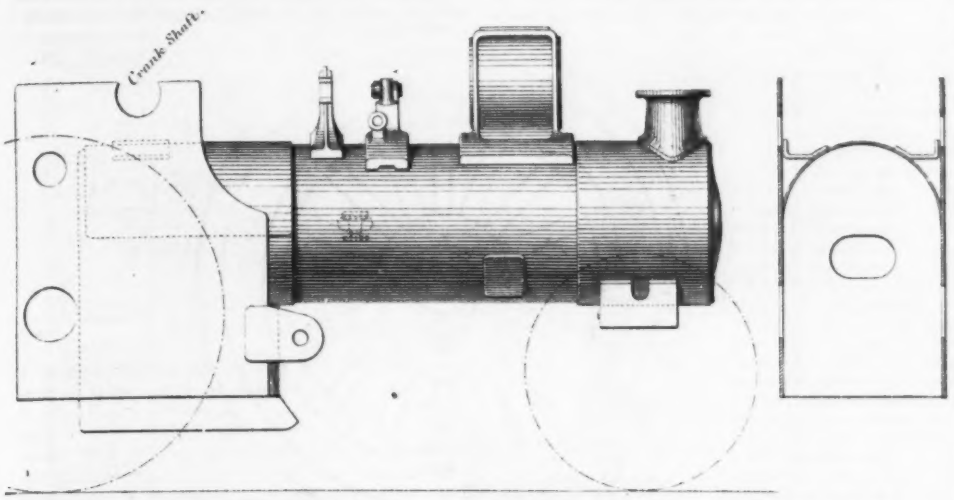


FIG. 1. BOILER OF COMMON TYPE OF TRACTION ENGINE. SCALE, $\frac{3}{4}$ IN. = 1 FT.

OBSTACLES TO THE USE OF TRACTION ENGINES.

At the present time traction engines are chiefly used in agricultural work, and for the conveyance of merchandise and heavy traffic. The multiplication of tramways and the legislation restricting the use of steam carriages on public highways have prevented their adoption for passenger traffic to any extent. These legal restrictions have also greatly hindered the use of traction engines for freight traffic. Traction engines have been held to be a nuisance at common law. In nearly every case the owner is obliged to obtain a license from a Court of Quarter Sessions before he can run his engine upon any highway, and he may have to wait nearly three months before such a license will be granted; yet this license affords him no protection whatever against any person or public body raising the most frivolous objections to the passage of his engine. Further, in country districts the speed of the engines is limited to 4 miles per hour, and a man is required to walk not less than 20 yards in front. The road authorities have almost arbitrary power to forbid the use of certain bridges by a traction engine, even though they are of ample strength; and at the same time damage done to a bridge by a load drawn by a traction engine must be made good by the owner of the engine, whereas if the same load is drawn by horses any damage is made good at the public expense. Finally, in certain cities the officials have power to prohibit the use of traction engines on any road within their jurisdiction.

So much for the difficulties which lawmakers have interposed. To these have been added some important mechanical difficulties, among which are the gradients of some of the roads over which traction engines must travel, sometimes exceeding 1 in 10; the great difference in the surface of the roads, and the necessity of so constructing the engines that they may make sharp turns.

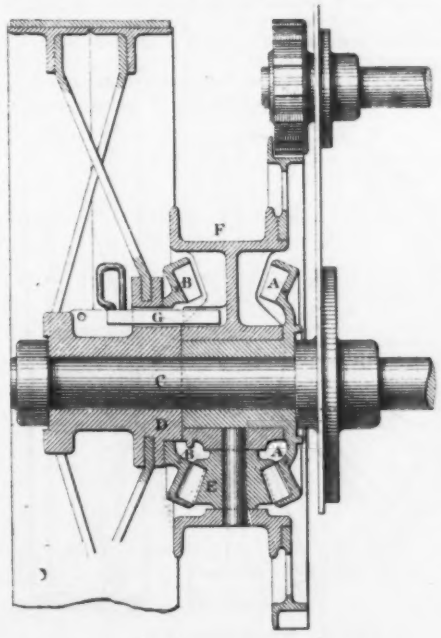
Notwithstanding all these difficulties thousands of traction engines are in daily use, and a number of firms make a specialty of their manufacture.

THE ORDINARY TYPE OF TRACTION ENGINE.

The author gives the following description as applicable, with slight variations in detail, to the engines of all the leading makers:

The multitubular type of boiler, horizontal cylinders, and the link-motion reversing gear are almost exclusively adopted. In order to reduce the weight of the engine, all separate framing is dispensed with as far as possible, the cylinders and various working parts being bolted direct upon the boiler (Fig. 1), which is constructed with a sufficient margin of strength to resist the additional strains from the machinery. It is usual to transmit the power of the engine from the crank shaft to the main axle through a train of gearing, which not only enables a comparatively small engine to exert a great tractive force, but also facilitates the use of large driving wheels, and at the same time reduces the speed at which the engine can travel to that prescribed by law.

As a rule, the cylinder is placed on the forward end of the boiler near the chimney. It is generally cast within a steam dome, which forms a jacket, whence it derives a constant supply of dry steam, so that the tendency to prime is overcome. The steam regulator and throttle-valve may be contained in the same casting, and the safety valves may be conveniently placed on the dome cover. The steam-chest cover should be so situated that it can be removed for examining the slide valve while steam is up. The crank shaft is generally fixed at the firebox end, the intermediate shaft crossing the boiler-front just over the fire door, and the main axle being directly underneath the intermediate shaft, and generally below the foot plate between the firebox casing and the water-tank.



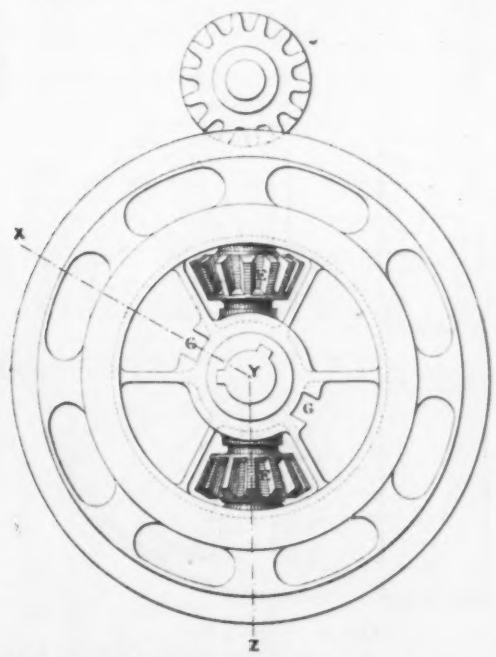


FIG. 2. COMPENSATING GEAR AND WINDING DRUM ON MAIN AXLE OF TRACTION ENGINE. SCALE, $\frac{3}{4}$ IN. = 1 FT.

The late Mr. THOMAS AVELING, M. Inst. C. E., designed a very simple, light and effective arrangement for carrying all the bearings for these various shafts. This consisted in prolonging the plates forming the sides of the outer shell of the firebox both upward and backward, bolting the crank-shaft brackets to the upper projections of these side plates, and those for the intermediate shaft and main axle to their backward projections. All the shafts were thus kept in position, and the gearing could not get out of pitch except by excessive wearing of the bearings or by tearing of the plates.

The boiler pressure ranges from 80 lbs. to 170 lbs. per sq. in., but the average working pressure may be taken as 130 lbs. The boiler must be well made, for in addition to the internal pressure it has to stand the racking strain caused by the working of the engine and shocks resulting from the rough jolting over bad and uneven roads.

The boiler shells are generally made of Siemens-Martin mild steel, with a strength of from 27 to 30 tons (60,480 lbs. to 67,200 lbs. per sq. in. and an elongation of about 25% in 6 ins. The circular seams are single-riveted and the longitudinal seams are double-riveted. Butt joints are seldom met with. The fireboxes are generally made of best Yorkshire iron or mild steel, and the tubes of wrought iron, lap-welded. These are swelled $\frac{1}{8}$ in. at the front end, and can therefore be easily withdrawn for scaling or renewal. So far as the experience of the author is concerned, the most satisfactory material for the construction of traction-engine fireboxes is mild steel. Solid iron firebox foundation and fire-door rings are now used in preference to Z iron rings. The water space around the firebox varies in width from about $2\frac{1}{4}$ ins. as a minimum at the bottom to 3 or 4 ins. at the top, thus giving a good circulation where it is most needed.

The recent improvements in the manipulation of steel castings have been of great service to the builders of traction engines. This material is now almost exclusively used for the spur gearing transmitting the power of the engine to the main axle. The wheels can thus be made of extraordinary strength without excessive weight. This gearing is arranged so as to give a choice of two speeds upon the road, viz., about 2 or 4 miles per hour, the latter being the maximum speed allowed by the present acts of Parliament.

The driving wheels of every traction engine should be fitted with differential or compensating gear, to enable them to turn sharp curves without any great loss of power, and without unduly straining the axle by the surging or slipping of the inside wheel.

This compensating gear consists of a pair of strong cast-steel bevel wheels, *A B*, Fig. 2, disposed face to face, the one, *A*, keyed firmly upon the axle, *C*, the other, *B*, secured to the boss, *D*, of one of the road wheels, which is mounted loosely upon the axle. Two bevel pinions, *E E*, are mounted upon pins, or studs carried between the aforesaid bevel wheels, the teeth on one side of the pinion gearing into one bevel wheel, *A*, and those on the other side of the pinion gearing into the other bevel wheel, *B*. This is a modification of a well-known movement which was first employed in WHITE'S dynamometer, and published in his "Century of Inventions" sixty-eight years ago, and it is now largely used where a differential movement of road-traveling wheels is required, as in traction engines, tricycles, etc.

In connection with the gearing of a traction engine a most valuable feature is the winding-drum, *F*, which is generally fixed on the main axle, between the road wheel and the firebox casing. By an arrangement of pins, *G*, the road wheels may be thrown out of gear, and the winding-drum made to revolve upon the main axle without moving the engine (Fig. 2), in which the winding drum and differential gear are combined. The whole power of the engine may thus be concentrated upon this small drum, round which a steel cable may occasionally

be used with great advantage. For instance, the engine may be loaded with a heavy casting or other weight up to the limit of its power with the slow gear. It may be able to haul this load on ordinary roads where there are no heavy gradients, but quite unable to mount with it up a steep hill. In the latter case the engine would be detached and moved to the top of the hill, the load being left at the bottom; the road wheels would then be thrown out of gear and firmly "scotched," and the rope or cable would be made fast to the load, which could then be wound to the top of the hill with the greatest ease. It is evident that this arrangement of drum and rope may be made to serve a variety of useful purposes.

The crank shafts are usually bent out of a round bar of mild steel, with collars welded on to form the journals. The intermediate shaft and main axle are usually forged of the same material.

The road-traveling wheels are variously made, the simplest form consisting of cast-iron rim and boss (Fig. 3), with wrought-iron spokes, the ends of which are cast within both the rim and the boss, and with wrought-iron or steel crossplates riveted on the face of the rim. A better wheel is made by putting two rings of wrought-iron tee-bar (welded and blocked to a true circle) side by side (Fig. 4), either with a wrought-iron cover plate and wrought-iron or steel crossplates riveted on, as at *H*, or with the cross plates riveted directly to the tee-bars, as at *I*. In either case the boss of the wheel is cast around the wrought iron tee-headed spokes, which have been previously placed in position in the sand. Holes are drilled through the spokeheads and the tongue of the tee-bar, which are then firmly riveted together by powerful machinery.

The best arrangement for the fore-carriage consists in mounting the front axle beneath a cast-iron bearing, which forms a sort of turn-table, supporting the front end of the boiler. The axle is carried beneath by a horizontal pin, upon which it rocks, so that there is a sort of universal joint under the front end of the engine, permitting the axle both to tilt vertically, the wheels accommodating themselves to any inequalities of the road, and also turning in a horizontal path to such an extent as may be required for the purpose of steering the engine. The steering gear is generally worked from the footplate by a worm and wheel at the end of a transverse horizontal shaft, around which are coiled double chains—one winding and the other unwinding as the shaft revolves. The front axle is thus drawn into and held in whatever position is required for turning the engine or for traveling straight forward.

The water and coal are carried at the rear of the engine, the top plate of the water tank forming a foot plate for the driver and steersman, coal being carried behind the driver, where stowage is provided for about an ordinary day's supply; but the water tank usually requires replenishing several times in the courseof a day's work. For this purpose the engine should be fitted with a "water lifter," a little instrument on the principle of the Giffard injector, fixed in the tank and fed with steam from the boiler. By means of an india-rubber suction-hose the tank may thus be filled in a few moments with water drawn from any convenient brook or pond.

The engine must be fitted with reversing gear, so that it may be driven in either direction. The flywheel should also be arranged so that a belt may be conveniently led from it to drive any machine or line of shafting. A set of governors should also be provided for service when thus employed, though they are very seldom used while traveling upon the road. An additional tank may be placed underneath the barrel of the boiler if required; and the lid of a toolbox fixed alongside the boiler forms a convenient platform for the attendant when cleaning or examining the engine.

A sufficient amount of weight on the driving wheels is required to absorb the full tractive power of the engine, but excessive weight upon the front wheels increases the friction of the steering gear, and causes the front wheels to "burrow" among loose material on the road. It is therefore advisable to put the bulk of the weight upon the hind wheels (which may be made wide enough to carry it), leaving sufficient weight only upon the front wheels to enable them to control its direction.

USUAL CAPACITY OF TRACTION ENGINES.

With respect to single-cylinder traction engines, the following particulars are the result of many years' experience: Each nominal horse power requires approximately 10 circular ins. of piston area. The actual horse power is about four times the nominal; piston speed, 350 to 400 ft. per minute; working pressure, 130 lbs. per sq. in.; heating surface, 17.5 sq. ft. and grate area 0.75 sq. ft. per nominal HP.; coal consumption, 4 to 4.5 lbs. per I. HP., with a consumption of water of about 28 lbs. per I. HP., equal to an evaporation of, say, 7 lbs. per lb. of coal. These are not very economical results, but it must be borne in mind that simplicity of construction is considered of more value than the economy obtainable from feed-water heaters, a high grade of expansion or any elaborate arrangements tending to complicate the mechanism of the engine.

The net useful load which can be drawn by any traction engine depends greatly on the nature of the road. With ordinary wheels, on smooth pavement or on slippery or "greasy" roads, the engine may have much difficulty in propelling itself alone up an incline, while on good dry and sharp macadamized roads it might possibly haul a gross load of three times is own weight upon the same gradient. On a level road the resistance due to a thick coating of newly laid road metal may be equivalent to an incline of 1 in 10 on a good hard road.

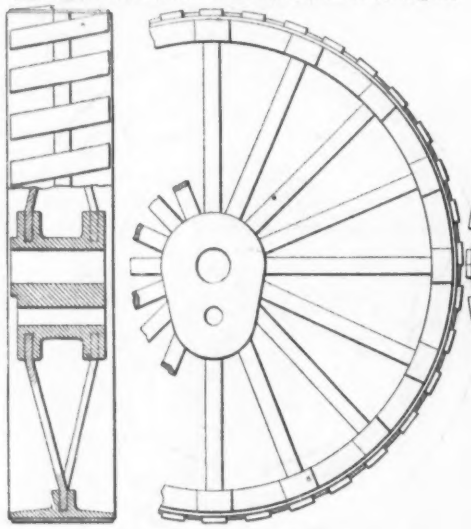


FIG. 3. Cast-Iron Rim.

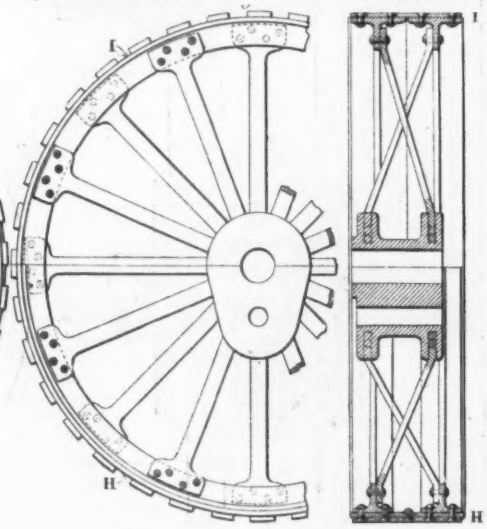


FIG. 4. Wrought-Iron Rim.

COMMON FORMS OF ROAD WHEELS. SCALE, ¼ IN. = 1 FT.

The following table shows approximately the gross and net effect which can be obtained from single-cylinder engines cutting off at about ¾ stroke on macadamized roads in fair condition:

Nominal HP.	Weight of engine (empty), in tons.	Weight of engine in working order (tons).	Steam pressure, in lbs. per sq. in.	Indicated HP. at 400 ft. piston sp'd.	Number of wagons in train.	Weight of empty wagons, in tons.	Net load (contents of wagons) suitable for level roads.	Gross load (engine, wagons and contents) on level.	Net load on incline of 1 in 10.	Net load on incline of 1 in 10 (extra good road).
							Tons.	Tons.	Tons.	Tons.
6	9	10	130	25	2	5½	12	27½	9	10
8	10¾	12	130	35	2	5½	16	33½	12	14
12	13	15	130	55	3	8¼	21	44¼	18	21

IMPROVED FORMS OF ROAD WHEELS.

As the weight which can be hauled by a traction engine depends on the adhesion of the driving wheels upon the roads, numerous attempts have been made to produce a wheel with sufficient elasticity in the rim to present (when compressed by the weight of the engine) an enlarged bearing surface upon the road. A number of such wheels are described in Mr. HEAD'S paper, the whole of which are now practically obsolete.

The wheel illustrated in Fig. 5 has been recently brought out by Messrs. J. and H. MCLAREN and Mr. I. W. BOULTON. It is being manufactured by Messrs. John Fowler & Co., Messrs. Aveling & Porter, and Messrs. J. & H. McLaren. It has a broad cast-iron rim, *a*, with cells or slots, *b*, about 6 ins. square cast all round its circumference. These cells are 6 or 8 ins. deep, closed at the bottom, but opened toward the outside of the periphery of the wheel. A hard-wood block, *c*, cut lengthwise of the grain, is fitted loosely into each cell, one end projecting a little beyond the rim of the wheel, and the other bearing upon an elastic pad or buffer, *d*, between it and the bottom of the cell. A suitable provision is made to prevent the blocks from dropping out as the wheels revolve. When the engine is in motion the weight upon the rim of the wheel compresses the blocks so that those in the lowest and adjoining cells come in contact with the road at the same time, forming a large and continuous flat tread to the wheel and so increasing its adhesion on the road. On paved streets the use of these wheels is specially advantageous, for not only is the tractive power of the engine enormously increased, but possible damage to the paving setts, caused by the chipping action of ordinary wheels, is entirely avoided. A considerable number of engines furnished with these wheels have been at work in the Manchester district for some years, and the results have been so satisfactory that certain local authorities, who, by virtue of special powers had practically prohibited the use of traction engines within their districts, have waived their restrictions in favor of engines mounted upon these wheels. As an instance of the advantage resulting from the use of these wheels, it may be stated that recently an 8-horse engine fitted with them moved a boiler weighing 30 tons on a trolley of 9 tons weight from Dukinfield to Oldham without any difficulty.

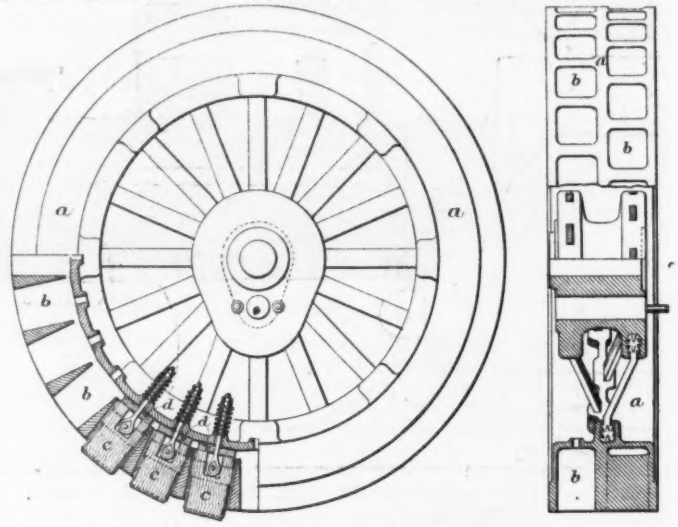


FIG. 5. MCLAREN'S AND BOULTON'S IMPROVED FORM OF ROAD WHEEL. SCALE, ½ IN. = 1 FT.

SPRING GEAR FOR TRACTION ENGINES.

Experience has shown that great wear and tear is occasioned by the shocks sustained by engines without springs in traveling over rough and uneven roads. The wood-block wheels serve as an excellent spring, effectually breaking the shocks and increasing the durability of the engine. Nevertheless, a great deal of attention has been directed to the question of mounting traction engines upon springs, and several ingenious and fairly successful plans have been brought into use. The great obstacle consists in the presence of the steel spur driving gear, which makes it difficult to allow any movement of the axle without throwing the teeth of the various wheels and pinions out of pitch.

The use of spring wheels forms one fairly successful solution of this difficulty, and about one hundred engines fitted with them are at work, giving satisfactory results. The driving-wheels are constructed of double rings of iron tee-bar with steel cross-plates riveted on with countersunk rivets. The boss or nave of the wheel has wrought-iron ribs, to which the spokes are bolted. These spokes are made of the best spring-steel plates about 9 ins. wide by ⅛ or 5/16 in. thick. Each plate is bent to a pear-shape, with the narrow portion fastened to the nave, and the crown resting upon the rim of the wheel where the plate is divided, the two ends being held in their places by a clip fastened through the rim with two strong bolts.

When the weight of the engine comes upon this wheel, the lower spokes are compressed, and those at the top are elongated a little. In order to avoid putting twisting strain upon these spring spokes, the driving force is not communicated to the rim through them, but is transmitted through a strong driving arm fixed to the differential gearing wheel, and coupled by a link to the rim of the driving wheel. The front end of the engine is carried

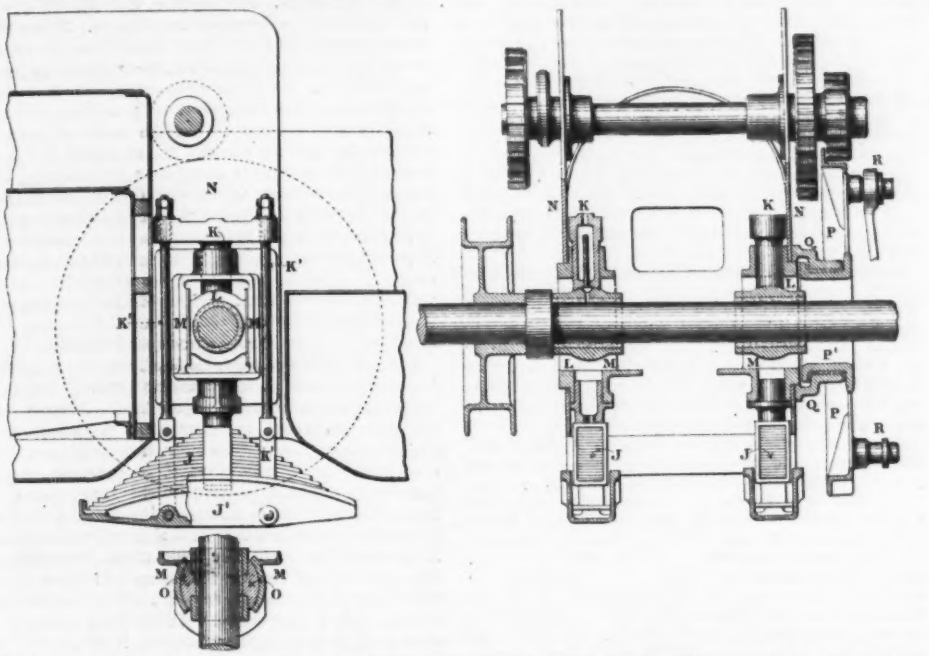


FIG. 6. J. & H. McLAREN'S SPRING ARRANGEMENT FOR TRACTION ENGINES. SCALE, ½ IN. = 1 FT.

on a pair of Timmis's helical springs, a slot-hole in the bed castings allowing the center pin to move up and down as the working of the springs may require.

The following arrangement of spring gear for driving wheels, introduced by the author's firm, is perhaps more mechanical than that of spring spokes. The engine in this case is mounted on laminated springs, *J J* (Fig. 6), of the same pattern as is usually employed in locomotives. Each spring, which is suspended under the axles through vertical links and a cross-head, takes a bearing, *K K*, upon the axleboxes, *L L*, which are free to slide up and down in the guides, *M M*. These guides are fixed to the side plate of the firebox, *N N*, which is carried backwards for the purpose, as already described. The axlebox *L L*, consists of a bushed casting having two slippers, *O O*, trunnioned into it, and turned in a circular form to slide vertically in the guides, *M M*, which are bored out hollow for the purpose. In the event of one wheel mounting an obstacle and causing the spring to act more on one side than on the other, the slippers still maintain their vertical position, while the bearing is free to accommodate itself to the angle taken by the axle. In order to admit of the axle thus moving vertically without the teeth of the spur gearing being thrown out of pitch, the main spur driving wheel *P* is not fixed on the axle, but is carried in a strong cast steel bracket *Q*, fastened to the side-plate *N* of the firebox. This is in the form of a clasp, bushed with brass, grasping a large trunnion P^1, cast on the back of the main steel spur driving wheel, which is thus maintained in pitch with the main driving pinion. On the face of each driving wheel are two strong crank pins *R R*. Wrought iron links R^1 R^1 (Fig 7) are coupled at one end to these pins respectively, and at the other end to the main driving boss *S*, which carries the toothed pinions *T T* of the differential gear. It is evident, however, that if these links R^1 R^1 were coupled directly and rigidly to the driving boss *S*, when the two points of connection were in a horizontal position, the springs on the main axle would become inoperative, the one link being in tension and the other in compression. The main driving boss *S* is therefore driven through the two intermediate cross-shaped bell cranks *U U*. These bell-cranks work on pins, *V V*, which fix them to the main driving-boss, *S*. The links, R^1 R^1, take hold of each of them respectively by the outer end, through the pins, V^1 V^1, and the two legs of each bell-crank rest on the pins, *W W*. These pins pass through the rim of the main driving-boss, *S*, and are screwed into washer-plates, *X X*, which bear on coil-springs, *Z Z*. These plates and springs serve the double purpose of breaking the shock occasioned by suddenly starting the engine, and permit the carrying springs to act in any position of the driving-wheels.

This arrangement has been found in practice to answer admirably. Three engines so fitted were sent to France to run a light parcels service between Grenoble and Lyons, a distance of nearly 70 miles. The journey had to be accomplished by night, between the hours of 7:30 P. M. and 7 A. M., or at an average speed, including stoppages, of rather over 6 miles per hour. About two and a half hours were spent in stoppages at various towns to take up and set down packages, so that the average speed maintained was nearly 8 miles per hour. The roads in many places were very bad, being crossed at intervals by numerous open drains or water channels into which the engines dropped with great violence. Nevertheless the service was accomplished with great regularity, and without a single accident in the working of the springs. Engines of similar design are now employed in New Zealand, Brazil, etc., on rough roads without giving the slightest trouble.

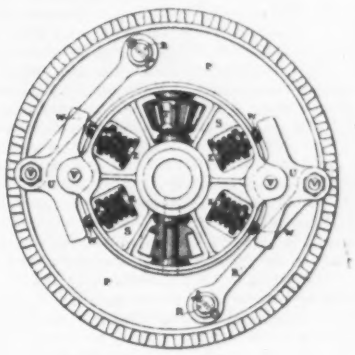


Fig. 7.

Messrs. John Fowler & Co., Leeds, who were among the earliest makers of traction engines, have adopted a system of volute suspended springs acting directly upon the axle. The axleboxes are free to slide vertically in horn blocks, and the pitch of the gearing is kept true by

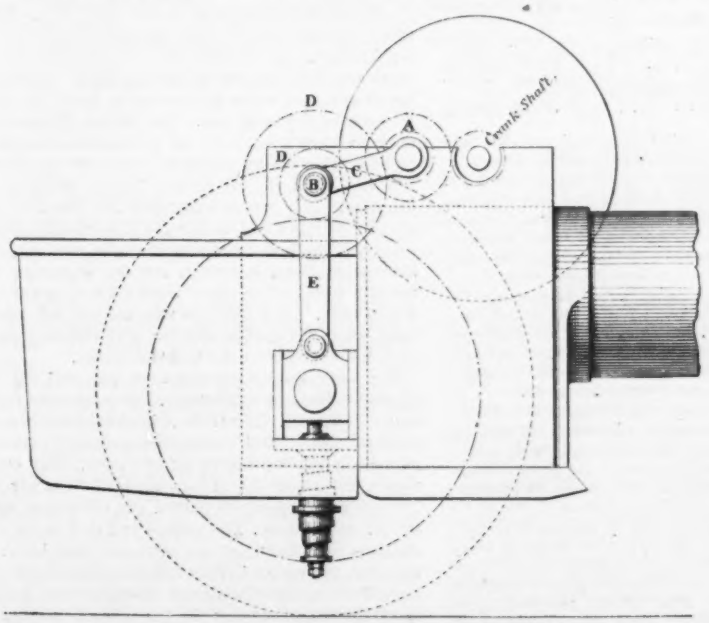


FIG. 8. FOWLER & CO'S. ARRANGEMENT OF SPRINGS. SCALE, ½ IN. = 1 FT.

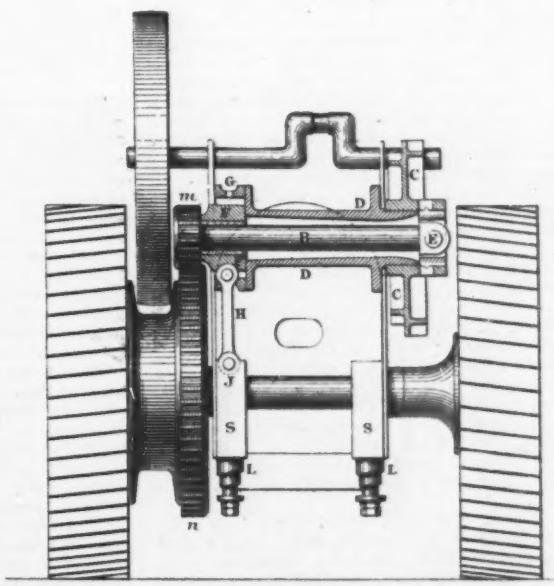


FIG. 9. BURRELL & SON'S SPRING ATTACHMENT. SCALE, ½ IN. = 1 FT.

coupling links between the shafts, which are thus allowed to vary their relative positions, as may be required by the action of the springs, without altering the distance apart of their respective axles. This system is illustrated in Fig. 8, where the second-motion shaft *A* runs in fixed bearings. When the springs are in action the intermediate or third-motion shaft *B* moves round the second-motion shaft as a centre, being held in position by the radius links *C C*. Through this shaft the power of the engine is transmitted to the main gear by the wheel and pinion *D D*. This, again, is held in its proper position in relation to the main axle by a second pair of coupling

links *E E*, so that a sufficient range is given to the springs without interfering with the proper pitch of the spur driving gear.

Messrs. Charles Burrell & Sons have also introduced an ingenious device for the same purpose, which is illustrated in Fig. 9. In this arrangement the crank shaft runs in fixed bearings, and communicates motion to the counter shaft *B* by means of a pinion gearing into the spur-wheel *C*. This wheel revolves upon a fixed steel stud in the form of a tube *D*, to which the countershaft *B* is connected by a universal joint *E*. The other end of the countershaft is carried in a bearing *F*, free to move up and down in the horn-block *G* bolted to the side plates of the firebox, which are carried backwards for the purpose. The bearing, or axlebox *F*, is coupled by a link, *H* to the axlebox *J* of the main axle, which is free to move vertically in suitable guides *S*, fixed to the horn-plates, so that both axleboxes rise and fall together with the movement due to the action of the springs *L*. The power is communicated from the countershaft *B* by a pinion *m* gearing into the spur-wheel *n*, which brings the power of the engine to bear on the main axle in the ordinary way. The steel tube *D*, which also forms a stud for the double-speed spur driving wheel *C*, is carried quite across the engine, and takes a bearing through the intermediate axlebox *G* upon the main horn-plate, thus forming a very solid support for the spur-wheel, as well as a substantial stay for the two horn plates. Volute springs, like those of Messrs. Fowler & Co., are employed, being readily accessible for adjustment or repairs.

COMPOUNDING TRACTION ENGINES.

The practice of making traction engines upon the compound principle is increasing, though by far the largest number of engines now at work have single cylinders. Each type has advantages. A single cylinder engine is able to concentrate a larger amount of effort into a single "lift," or for a short "sprint," when required to lift itself or its load out of an awkard hole, or over a bad length of road. But where coal is expensive, or water scarce, compound engines have a decided advantage, as in favorable circumstances an economy in fuel of as much as 30% may be effected. Moreover, the shocks upon the crank-pins, gearing and other working parts are less severe, and as the steam is expanded down nearly to atmospheric pressure, the noise of the exhaust is much reduced, and the danger of frightening horses considerably diminished.

On the other hand, compounding considerably increases the number of working parts, though the wear and tear is not necessarily increased in the same proportion, as the strains on the various parts are (with double-crank engines) to a large extent reduced. With tandem cylinders, or with both cylinders working on one cross-head, the strains, instead of being reduced, may really be intensified, and one advantage of compounding is thus altogether lost.

The best ratio of cylinder capacity has been found in practice to be about 2.4 to 1. The steam-chests should always be to the outside, so as to be easy of access for examination or adjustment, and a handy "pop" valve is usually provided, so that the driver can turn a sufficient supply of high-pressure steam into the low-pressure cylinder to start the engine in the event of the cranks standing in a position in which the engine will not start in the usual way.

RECORDS OF WORK DONE BY TRACTION ENGINES.

The following examples show the work actually done by several sizes of traction engines.

Hauling Marine Boilers.—This duty is efficiently performed by an engine of 12 nominal HP., with two high-pressure cylinder, each 8 ins. diameter by 12 ins. stroke. It is working regularly in the streets and on the docks at Liverpool, hauling all sorts of heavy traffic, but is especially adapted for moving large marine boilers from the different engineering works to the ships lying in the docks. In one case the total load, exclusive of the weight of the engine, was 80 tons; viz., a boiler weighing 60 tons, on a trolley weighing 20 tons. To move this weight at least 60 horses and 30 men would have been required, seriously interrupting the traffic for hours; whereas in this case three men with the traction engine delivered it under the crane on the quay, a distance of nearly 2 miles, in about 55 minutes.

Crane Engine.—A traction engine, with a single cylinder, 10 in. diameter, 12 in. stroke, with ordinary rigid wheels, and a 7-ton crane in front, is in regular use in one of the large marine engineering establishments in Gateshead, where it is used as a portable traveling crane, as well as for hauling marine boilers and heavy castings to the 60-ton crane on Newcastle quay. In this case the principal difficulty consists in braking these heavy loads down a steep incline, which in places is as much as 1 in 10; and the loads to be dealt with occasionally reach 52 tons, including the wagon, but apart from the weight of the engine.

General Heavy Haulage.—In the Sheffield district, a number of men who call themselves "contractors" have each acquired from three to six traction engines, and either let them by the day, or themselves undertake the moving of heavy loads. In this way large quantities of flour, coal, etc., are daily sent to the outlying villages in the Peak district, which has hitherto been without railway communication. One contractor is largely employed at iron and steel works, moving heavy articles, such as armor-plates, hammer-blocks and other weights occasionally exceeding 50 tons. He is also employed in hauling, by road, boilers, spur-wheels, stern-posts and other bulky articles which cannot be conveniently carried by rail. These are frequently taken long distances, such as to Newcastle, Liverpool, etc., without any trouble. Another contractor in the Peak district traverses a distance of 32 miles daily with an 8-HP. engine. The trip consists of a 16 miles journey to the railway station with the empty wagons, returning the same distance with a load of 13 tons of coal. The weight of the two wagons is 5½ tons, making a gross load of 18½ tons, exclusive of the weight of the engine. This performance has been maintained for several years, making an average of 192 miles per week. In summer weather, with good roads, the outward journey has been frequently made with a load of about 12 tons of limestone for road repairs. This involved a detour of several miles, which brought the average distance traveled up to 205 miles per week.

In the granite district of Leicestershire, at a large quarry where formerly both horses and a traction engine were used, the comparative cost of transportation was found to be no less than £422 ($2,386.20) in favor of the engine in a single year. Consequently steam power has been since that time exclusively adopted. Such instances could be multiplied indefinitely, but sufficient has been said to prove the enormous economy of steam for road haulage compared with animal power.

Thousands of steam traction engines are used for agricultural purposes, but the work in which they are employed presents no features of special difficulty.

With respect to the cost of working traction engines on common roads, the following figures, based upon actual experience, may be taken as a fair average, when working under normal conditions. The data refer to an 8-HP. engine, one of a number owned by a contractor near Doncaster. This engine is principally used for hauling bricks and tiles from their place of manufacture into the country, an average distance of 17 miles. The cost of the engine, ready for the road, was £560 ($2,716); and the price of four wagons, mounted on springs and fitted with drawbars, screw-brakes, etc., complete, was £332 ($1,610), or a total capital expenditure of £892 ($4,326), or say £900 ($4,365).

	£ s.	£ s.	
Interest on £900 for twelve months at 5% per annum		45 0	$218.25
Depreciation and renewal of capital at 15% per annum		135 0	654.75
One driver 52 weeks at 30s. ($7.27)	78 0		
One steersman 52 weeks at £1 ($4.85)	52 0		
One assistant 52 weeks at 18s. ($4.37)	46 16		
	——	176 16	857.48
Oil waste, stores, etc., 300 days at 2s. 6d. ($.55)		37 10	181 88
Coal, 300 working days at 10 cwt., 150 tons at 15s. ($3 63)		112 10	544.62
Making the total working expenses per annum		506 16	$2,456.98

Taking a useful load of only 12 tons each trip, the total weight handled in 300 working days would amount to 3,600 tons carried a distance of 17 miles, or 61,200 ton-miles, which, divided into £506 16s., would give a rate of 1.98d., or a trifle under 2d. ($.04) per ton per mile, or a saving of at least 75%, compared with the cost of doing the same work by horses This economy would naturally be much increased if the engine could be loaded both ways.

In view of this great saving in the cost of carriage, the limited use of steam on common roads may at first sight appear surprising. It is, however, easily accounted for by the number of restrictions already referred to under which the engines are worked, and the prejudice which exists against them, especially in rural districts.

The fact that so many engines are engaged in doing the heaviest class of road haulage, in all parts of the country, with a wonderful immunity from accident, would appear to indicate that the time has come when these irksome restrictions might be wholly removed, while, on the other hand, more stringent regulations might be imposed, for the protection of the general public, without detriment to the real development of this important means of transport. Amongst other things, a compulsory inspection of boilers is urgently called for, as it is well known to makers of traction engines that many boilers are working in public places at pressures for which they are not at all suitable, and are consequently a constant source of public danger. Some test of fitness should also be exacted from those who are put in charge of such engines. Many are entirely ignorant of the responsibility which attaches to them, and the risk which is daily incurred through their incapacity or carelessness.

The discussion of the paper was principally on the legal restrictions to the use of traction engines. The chief causes of opposition to traction engines were the setting fire to thatched roofs, hay ricks, etc., by sparks from the funnel, the damage done to the roads and the danger to life and property by scaring horses. Sir FREDERICK BRAMWELL suggested that the first of these objections might be met by "putting a grating in the smokebox just above the tube level," and the author said that fires set by traction engines are exceedingly rare.

The effect of traction engines on the roads is a much more serious matter. Mr. HENRY MCLAREN acknowledged that the ordinary road wheel with traction plates (Figs. 3 and 4) was a barbarous thing to run over roads. But its use was chiefly due to the legislative restrictions as to speed. Since high speeds with light loads were forbidden, the engine must haul very heavy loads at slow speeds to work economically. To draw these very heavy loads a cogged wheel was necessary. It was suggested also that it would be fair to require users of traction engines to pay an annual fee of $50 to $125 for a license, this sum to be applied to maintaining the roads in the district where the engine is worked. The author said that the owners of traction engines would not object to this, provided it released them from liability for damage to roads or bridges by their engines. The use of the more expensive spring wheels or wheels fitted with wood blocks might well be encouraged by charging a smaller license fee, since the damage to roads was so much less.

The most difficult obstacle of all was the frightening of horses, and to this was due much of the popular antipathy to traction engines. Among the remedies suggested were covering the machinery, compounding the engines and using mufflers or air condensers for the exhaust. The covering of the machinery might be so done, however, as to increase the noise, and thus be an injury instead of a benefit. Most horses soon get accustomed to traction engines if properly handled. Sir FREDERICK BRAMWELL brought out well the unwise manner in which spirited horses are generally treated. After keeping the horse tied in a dark stable with his head towards a dead wall, it is thought surprising if he is nervous and frightened when suddenly brought out into the glare and bustle of the street.

Very interesting reports of the performance of traction engines were given by Mr. HENRY MCLAREN. Some of the McLaren compound engines fitted with the spring gear shown in Fig. 5 are working in New Zealand, hauling bales of wool from squatters' stations in the Grassmere district to Christchurch, about 75 miles. The road crosses Porter's Pass at an elevation of 3,000 ft. above sea-level, and has grades as steep as 1 in 8. Eleven rivers are crossed, all of them by fords, as there are no bridges. Their beds are of loose shingle and boulders, and the current is very rapid. In crossing these streams, when the water is high, the fire is frequently drowned out. The driver always takes care to have a full head of steam, however, before starting to cross, so that if he loses his fire he still has sufficient steam in the boiler to carry him through. It is rough treatment for the steel firebox, but it has stood it for years without apparent injury. It was found necessary to substitute wrought-iron grate bars, however, for the cast-iron ones usually used, as the latter were liable to break after a cold bath. As a rule the wagons are left on one bank while the engine crosses, and the wagons are then hauled over by the winding drum.

The train consists of three wagons, and the load carried is from 90 to 100 bales. The gross load hauled is about 20 tons. The train is in charge of only two men, the driver and steersman, and they make the round trip of 150 miles in 2½ to 5 days. The engine uses 1,000 to 1,500 lbs. of New Zealand coal per day. The working pressure is 160 lbs. and the piston speed 500 ft. per minute. The engine is fitted with three change gears, to run at 2, 4 or 8 miles per hour. In running, the steam is very seldom wire-drawn with the throttle, but the driver changes to a quicker speed instead of closing the throttle, or moving the reversing lever toward the center. The engine has run over 2,700 miles on this and similar roads for six months with not a breakage or failure of any description.

With regard to features of construction, the use of chain gear to transmit power to the main axle was referred to. The author said this had been abandoned, as the strains were too excessive, and serious accidents had occurred as a result of broken chains. Improvements in the manufacture of steel had made gear wheels durable and reliable.

The various arrangements of spring gear shown were criticised, and it was argued that the use of springs in the wheels was on the whole simple and

less expensive. An objection to the use of traction engines in cities was the vibration which they caused in surrounding buildings. In South Lancashire house furniture had been injured by this cause. The use of some effective kind of spring wheel would increase the life of the working parts of the engine as well as tend to remove much of the disfavor with which traction engines are regarded.

Caissons and Cribs for Quindaro Bridge.

[WITH INSET.]

The accompanying inset sheet shows with unusual completeness all the constructive details of the pneumatic caisson designed for the so-called Quindaro Bridge of the Wyandotte County Bridge and Terminal Co., at Kansas City, Mo., of which Mr. Mr. FRANK D. MOORE is Chief Engineer. In all its essential details the design corresponds with that for the last caissons sunk for the so called Winner Bridge at Kansas City, which was fully illustrated and described in our issues of March 15, 1890, and July 19, 1890, and was built by the Kansas City Bridge and Terminal Co., of which the Wyandotte Co. B. & T. Co. is merely an offshoot under another name, both companies having the same officers.

In an accompanying note Mr. FRANK D. MOORE, Chief Engineer of both companies, makes the following remarks in regard to this design:

I consider this design for pneumatic caissons the most economical arrangement of timber for strength and stiffness, and the arrangement of pipes, locks and shafting the best adapted to moving such materials as are encountered in this section of the Missouri River. The details shown are generally the same as were used in the last caissons sunk for our Kansas City Bridge and Terminal Ry. bridge at Kansas City, where they proved to be exceedingly economical.

In some of the piers in this locality we encounter about 10 ft. of bowlders overlying the bed rock, and these are removed by the "pressure men" placing them in the lock chamber, after which they are removed by a cheaper class of labor with buckets and hoisting engine. A cushion is kept on the bottom of the lock chamber under the shaft, and door No. 2 is closed under the bucket and each hoist as a safeguard. The small stone and other collections of miscellaneous material which are left by he dry blow-pipes *B* are blown out with the larger blow-pipe *W* with the "wet flexible." The dry blow-pipes *B* are used as soon as sufficient depth has been reached to give suitable pressure to work them. The sand pumps are used on these pipes in sinking to a depth sufficient to work the blow pipes. The 3-ft. shaft is generally used as an entrance shaft for the men, but a temporary iron or rope ladder is hung in the 2-ft. supply shaft, which is used in case of necessity, and the lower door of this shaft is kept open (when not locking in materials) for a safety shaft for the men.

Balance weights are kept on all doors. Clapper valves are kept on the air supply pipes. Pipe *E* is conduit for electric light wires. *A*. The 1-in. equalizing valves are used in the entrance shaft until 25 lbs. pressure per sq. in. is reached, when they are changed to ¾-in. valves. Two-in. equalizing valves are used in the supply shaft, operated from the outside at the top or from the inside of the shaft.

The above arrangement, so far as we used it on the Kansas City Bridge, has certainly proved to be safe, effective and economical. The doors, lock and diaphragms, as shown, are calculated to be perfectly safe to a depth of 116 ft., or 50 lbs. per sq. in. pressure. The formulas for calculations are given on plan.

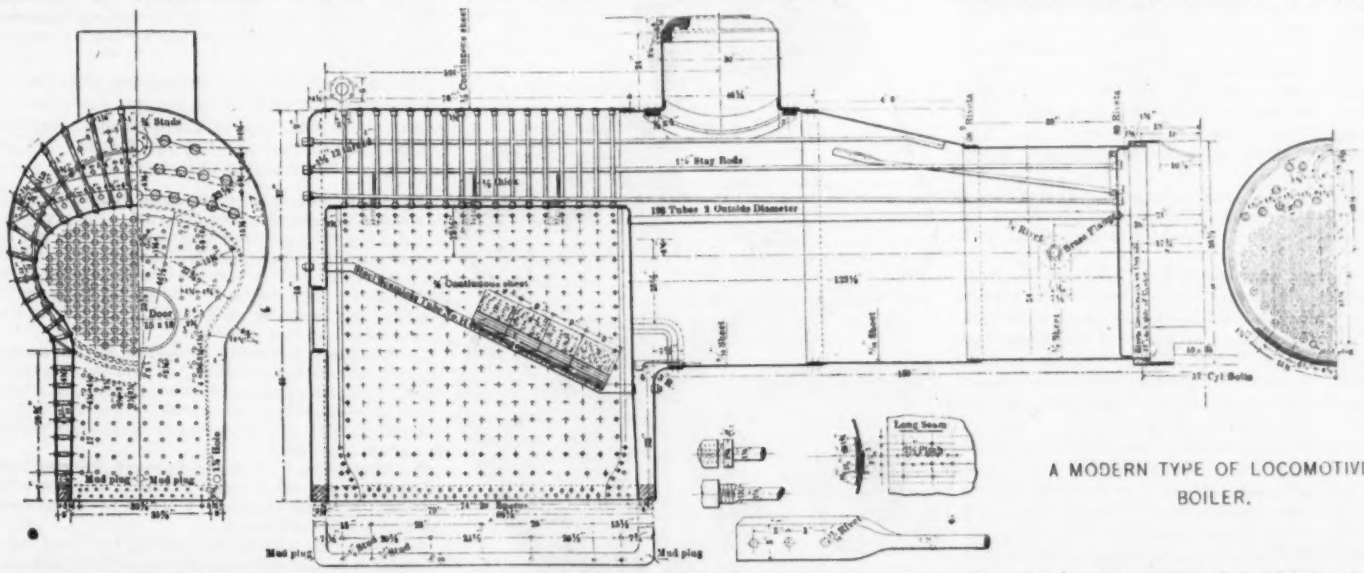
The accompanying drawings are so full and clear, that, beyond the details given in this letter, no description seems to be required.

Improvements in Locomotive Boiler Construction.

At the last meeting of the Western Railway Club a paper with the above title was read by Mr. JNO. HICKEY, who has just been appointed Supt. of Motive Power of the Northern Pacific Ry. He stated that a locomotive boiler well made, of good material and carefully managed should be safe for 20 years' service.

As the material for boilers, he favored mild steel as more durable and reliable than wrought iron, and free from blistering and other troubles peculiar to iron. Heating, flanging, and annealing steel plates for boilers should be entrusted only to skilled and careful men. Overheating steel while working it may do it an injury beyond the power of annealing to cure. Machine-riveting is far superior to that done by hand, since the rivet forced home by hydraulic pressure fills its hole more perfectly and adds strength to the seam by the increased friction of the surfaces in contact. Tests by the author have shown that double the power is required to slip a machine-riveted seam before its shearing that is required to slip a hand-riveted seam.

The accompanying illustration shows a modern type of locomotive boiler intended for a mogul locomotive with 18×24-in. cylinders, using steam at 165 lbs. pressure. The total capacity of the boiler is 255 cu. ft., of which 66½ cu. ft. is for steam room, with the water at ordinary height. This leaves 188½ cu. ft. for the water, or room for about 1,410 galls. Some of the principal improvements which have been made over older forms of construction were described substantially as follows:



A MODERN TYPE OF LOCOMOTIVE BOILER.

In the absence of crown bars, a system of radial stays is introduced, thus increasing the water space, and adding materially to the heating efficiency of the crown sheet, while the strength of the parts is increased. The wagon-top part of the boiler is extended for the purpose of placing the dome at a point where the interior of the boiler is accessible, and enlarging the steam space. The outer sheet of the firebox is seamless from the point of its junction with the foundation bar on one side, to that on the other, thus doing away with the necessity of joints in the sheet. Its circular form is also a feature of strength. The inner sheet of the firebox is also without longitudinal seams, except at the foundation bar, and is slightly crowned, for the double purpose of increasing its crushing resistance, and permitting, to some degree at least, a better line of connection for the radial stays between it and the shell.

In order to support the boiler head, it is customary in some quarters to introduce stay rods making a diagonal connection between the head and shell, instead of the long rods usually placed to brace the boiler head and front tube sheet. The principal objection to the diagonal supports is the additional holes in the shell which must be placed there for their attachment, and which, together with the holes created for the radial stays, reduces the strength of the shell at that point. The longitudinal tie rods connecting the boiler head and front tube sheet are quite as effective and less expensive.

The plate on which the dome is located is ⅞ in. thick, all the others being but ½ in., except the throat sheet, which is ⅝ in. thick. The boiler sheet is flanged upward for the dome attachment, and a sustaining ring about ⅝ in. × 4 in. is fitted at the base for the purpose of adding to the strength of the boiler at this point.

For years we have been troubled with leaky corners at the foundation ring in fireboxes. In recently constructed boilers the end sheets of the firebox have been extended a few inches at the base, for the purpose of carrying the joint beyond the corner, thus getting the seam along the side a few inches from the latter, as shown on the drawing. This plan of construction has wiped out entirely the evil of leaky corners.

To guard against the danger of a number of broken stay-bolts in proximity to each other, a small hole is drilled into the outer end of each to the depth of 1 in., and, as the stay-bolt breaks usually at a point near the outer sheet, the leak following the fracture of the bolt will at once locate the trouble.

TUBES.

The tubes are situated in vertical rows to permit a good circulation and a free passage for the impurities of the water to the bottom of the boiler, where they can be removed. It is true that with this manner of locating tubes, a less number is had than is admissible in a sheet where they are placed zigzag, but experience has shown that what heating surface is lost by the less number is far more than gained by the advantages just named. It is established beyond doubt that the steam-producing power of the boiler is not always increased in proportion to the increased number of tubes, unless sufficient space is permitted between the tubes for free circulation; indeed the reverse may be the result.

It may be well to consider the diameter of tubes best suited to the consumption of bituminous coal. Custom, perhaps, has somewhat established the almost universal use of 2-in. tubes. It appears to be an unsettled question, however, whether this diameter has been reached from tests made, and the results of experience, or whether custom alone has settled the matter. Something, no doubt, can be said in favor of the use of tubes of both larger and smaller diameters. It is claimed for tubes of 1¾ in. and 2 in. diameters that, from the increased number which can be placed in equal areas of tube plates, the heating quality of the boiler is augmented because of a better distribution of the heated currents. On the other hand, it is claimed for tubes of 2¼-in. and 2½ in. diameter that they are not as liable to stop up with common coal as 2-in. In the absence of any reliable data on this question from which conclusions of value could be reached, I incline to the opinion that, under the conditions of operating locomotives in this Western country, tubes of 2¼-in. diameter would give fully as good results in boiler efficiency as smaller tubes, and would be less liable to stop up.

With small tubes the flame is extinguished as soon as it enters the tube; and, unless complete combustion takes place in the fire-box, the result must be the escape of unconsumed gases with consequent waste of heat. With the use of larger tubes, the flame enters in larger volumes, thus prolonging the action of combustion.

In boilers of this type there has sometimes been trouble from the surging of the water in the boiler when sudden stops are made by trains at high speed. To remedy this, swash-plates have been introduced, reaching across the boiler at a point about 5 ins. above the crown sheet and attached by angle-irons to the outer sheet.

Steam domes should be no larger than is necessary

to give room for the throttle-valve and other attachments, and should not be relied on to furnish steam room for the boiler. Mud drums, which have gone out of fashion at present, the author believed to be a good thing for roads having bad feed water.

The author condemned shallow fireboxes, except when made with a combustion chamber between the fire and the tube sheet. Otherwise the distance from the surface of the fire to the tubes is so short that there is not room or time for thorough combustion before the gases enter the tubes.

Testing should be done periodically at a pressure 33% in excess of the regular working pressure, and the pressure should be maintained for some time, during which a careful examination of the boiler should be made.

Proper care is as essential to long life of a boiler as correct construction. Among the worst evils are washing out with cold water before the firebox has had time to cool; impeded circulation, from accumulations of scale or contracted waterways; permitting the entrance of cold air to a firebox immediately after dumping the fire; and too rapid firing up, which causes the tubes to be heated and expanded while the outside shell is cool.

Home-Made M. C. B. Ccuplers.

In our issue of March 14, 1891, we noted the fact that the McConway & Torley Co. had recently received among a lot of broken knuckles returned for renewals a *cast-iron* knuckle, badly broken, and of course quite incapable of sustaining when new more than a small fraction of the strain which the carefully made wrought-iron knuckles furnished by the manufacturers readily carry.

The company which was guilty of the moral (if not legal) crime of thus endangering the lives of trainmen and the public is as yet unknown, but we find we were mistaken in stating that it was sent in to the manufacturers by a western road. Mr. Wm. McConway, of the above-named company, writes us:

> The credit of the cast-iron knuckle to a *western* road is a mistake. It came to us from the *east*. So far as we know, no one in the West has been guilty of any such act.

This casting was branded "E 10," but on what road this particular casting originated is as yet unknown. It will be seen below, however, that similar castings have been used by one of the connections of the Boston & Maine road, and we also present herewith drawings of certain parts of another coupler whose origin is known, and which are justly open to almost equally severe criticism.

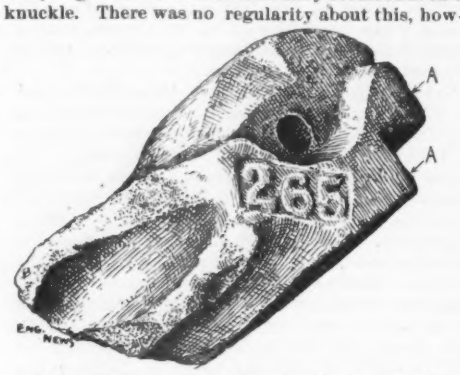
These parts are, first, a home-made cast-steel knuckle for the Gould coupler, branded "B. & A.—D 248," as shown, and, secondly, a *cast-iron* locking dog for the same coupler, branded simply "265," and hence bearing no direct evidence of its origin; but we are informed (we do not know how true it is) that the dog came from the same lot of couplers as the knuckles.

In the coupler, as finished by the manufacturers, this locking dog is made of the best malleable iron, and is practically as tough as wrought iron. That there is need of this toughness is evident from the fact that the faces, *A A*, are those which engage the tail of the knuckle and keep it from uncoupling. Consequently, every time any slack is taken out of the train, as also necessarily in the act of coupling, the faces, *A*, sustain a hammer blow, in addition to the continuous strain from the pull of the locomotive, all of which has an obvious tendency to splinter off a triangular block, of which one or the other of the faces, *A*, is one side, and so cause a break in two. It follows that cast iron is a most unsuitable and dangerous material to make such a dog of.

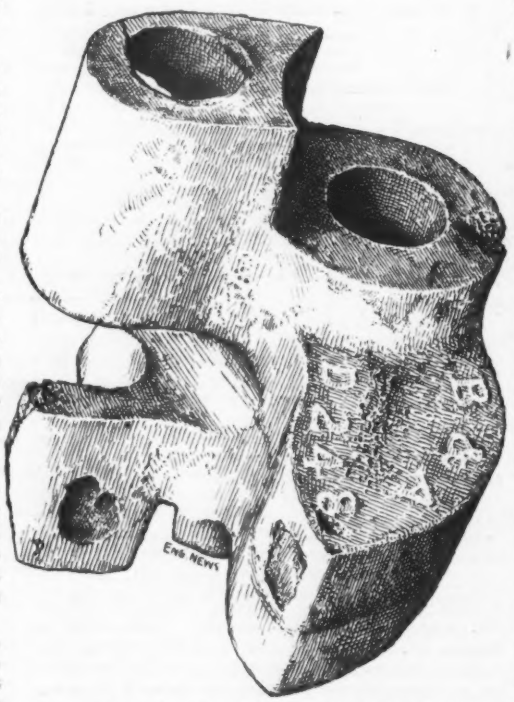
The knuckle illustrated is open to less criticism than the dog, in that it is of cast steel instead of cast iron. We are informed by the makers, however, that it is of a kind of cast steel to which they strongly object, in that it will not stand nearly as many blows of a sledge without injury as will the knuckles they are furnishing, and it is, moreover, open to serious and certainly well-founded objections in these respects:

1. It is not made to gage. Out of a lot of 7 of these couplers which we have seen none of them properly fitted the gage used by the manufacturers in inspecting knuckles, and most of them would not enter the gage at all, which is made loose enough to allow some considerable play. As the engagement of couplers made on the M. C. B. lines is close, it will be seen to be highly important that all knuckles put on should be to gage.

2. The pin-hole in the knuckle is eccentric on the wrong side. It is the custom of the manufacturers to make the metal about ¼ in. thicker on the outside than on the inside of the pin-hole, since the severest strains come on the outside, and it has bee found to diminish the percentage of wreckages. In the knuckle illustrated the metal is about ¼ in. *thinner* on the outside than on the inside, thus tempting the fracture which actually occurred in this knuckle. There was no regularity about this, however, most of the couplers having the metal of about equal thickness on both sides.



A Home Made Cast-Iron Locking Dog for Gould Coupler.



A Home Made Cast-Steel Knuckle for Gould Coupler.

HOME MADE M. C. B. COUPLER CASTINGS.

3. The lower beveled surfaces under the pivot-hole (not visible in the engraving), which in the genuine knuckles are cast against a chill-plate so as to be perfectly smooth, are in all these home-made knuckles cast in sand only and left extremely rough, most of them having large projecting knobs and fins. In this way one of the most valuable features of the Gould coupler—that the knuckle drops open of itself when unlocked, without any one touching it—is wholly sacrificed. Few of these knuckles could possibly open of themselves.

4. The castings as a whole are rough and crude. We do not allude to such ordinary roughness and imperfections as are inseparable from steel castings in the present state of the art. It is well understood that steel castings cannot be made as smooth and perfect as iron castings, but the imperfections on many of these knuckles go beyond all reasonable limit. For instance, the blow-hole shown in the extremity of the tail in the accompanying view extends entirely through the interior metal to the top surface, so that daylight is clearly visible through it; and this defect is at the very point where the tail of the knuckle has its bearing against the locking dog.

Finally, the question cannot but arise, what motive can there be for any one making these parts himself at all, and especially anyone known to have such decided and outspoken dislike of this whole class of couplers, now known as the M. C. B. standard, as has Mr. Adams, the Master Car Builder of the Boston & Albany R. R., from which road the knuckle at least emanated? It is a notorious fact that the manufacturers have, for the present at least, the strongest inducements (1) to keep up the quality and (2) to keep down the price of these repair parts to the utmost which is possible, and it hardly admits of denial that they are actually doing so. Each has every reason to be anxious (1) to further the rapid introduction of the M. C. B. type as a whole, and (2) to prevent all prejudice against their own make of this type as compared with other makes. If, therefore, any manufacturer is charging more for repair parts than some road finds it can get them made for at some foundry on its line, the inference is but natural that it is able to do this (if it in fact does it) because quality is sacrificed to cheapness. For instance, it will make a material difference with the price asked by any foundry whether there is a rigid inspection which causes many rejections, or no inspection at all. These causes, at any rate, have led all roads which favor the M. C. B. type without a known exception, to order all their renewal parts from the manufacturers. It cannot but be regarded as significant, that it is only the men who are strong opponents of the coupler who are fabricating renewal parts of their own.

We have before us the manuscript report of the January meeting of the New England Railroad Club, which sheds some light on this question. A general abstract appeared in our issue of Jan. 24. We give now only a few verbatim abstracts:

Mr. Adams (B. & A.), in opening the discussion: There is a wide difference of opinion in regard to the advantages of using the vertical-face coupler instead of the pin and link coupler. We here in New England are in the minority on this question, but we have the consciousness of believing that we are in the right. We do not believe in the coupler; and in saying so I think I speak for the New England railroad men generally.

Mr. Marden (Fitchburg): I think, as Mr. Adams said, that the New England roads are not in favor of the vertical hook coupler as it is given to us to-day, and I know that a large number of roads outside of New England are not; and I think the experience of these roads justifies them in that position.

Mr. Butler (N. Y., P. & B.): So many different kinds of drawbars are used, it is pretty hard to tell how much merit there is in this coupler. I would not receive any car with a defective coupler.

Mr. Robertson (Central Vermont R. R.): The Central Vermont has suffered seriously from this defective knuckle business. I am sorry to say for the manufacturers of the knuckles that I have found very miserable stock put into them—blow-holes in malleable iron, *and I have almost mistrusted that I have found some cast iron knuckles;* and my confidence in the vertical type coupler is about gone. I did at one time think it was better than the link and pin coupler, even with the Safford improvement, but my experience with it has not confirmed that opinion. I don't think we should receive knuckles damaged in any way.

Mr. Chamberlain (Boston & Maine). One of our connecting roads offered us two cars with cracked knuckles, and we refused to take them. *They hung the cars up for three or four days, and then offered them to us again, with new knuckles nicely fitted in, apparently all right, and we broke both of them before we got the cars out of the yard. We traced those knuckles right to a cast-iron foundry, a good many miles from any malleable iron foundry, too. In taking our connecting line inspector to task for that, he said he examined those couplers and thought they were probably made of cast-iron, and in fact he supposed they were all made of cast-iron.*

Mr. Lauder (Old Colony R. R.): If anything needs to be in perfect condition it is the drawbar of a freight car, because some of the most disastrous accidents on record have been caused by the breaking of drawbars. It is an old truism that the way to get a bad law repealed is to strictly enforce it. I believe the only way that the rail-roads of this country can get clear of this vertical plane coupler is to strictly enforce those rules that were first promulgated by the New York Central road—to refuse to receive cars with vertical plane couplers unless in perfect order.

The experience of the last two years has proved that the most dangerous thing on our roads is this coupler, and I trust that some organized effort will be made toward rescinding the action taken by the Master Car Builders' Association some years ago—action taken honestly, because they thought that type of coupler held out something better than we had before. That coupler in my judgment has got to be abandoned, because of its danger—*danger of breaking apart* and giving out on the road, and especially danger to trainmen using it; it is the most dangerous appliance they have to handle.

Mr. ADAMS: We have taken pains to get the cost to the Boston & Albany R. R. for three months in maintaining the vertical hook coupler; that is, the cost of repairing couplers for the three months of October, November and December. The different couplers are numbered, as we have them classified on our books. No. 249 has cost, in broken bars and broken knuckles, to maintain, $639.81; No. 248 has cost $2,168.68; No. 333 has cost $1,334.30; No. 334 has cost $222.25; No. 255 has cost $80.85; unknown (that is, couplers reported and the name not given), cost $144; making a total on our line of road of $4,389.19 for keeping up the couplers for three months. It will cost four times that for a year, and no road can afford to pay any such money for repairing their couplers. *We are making our own knuckles, and I believe we make a better knuckle and with better steel than most of the manufacturers; and we know that we are giving the other roads as good or better than we break.*

This coupler is represented as automatic, but it is not so; that is a mistake; because *ordinarily you have got to open the knuckle* on almost all, and perhaps all that have been made up to within the last three or six months, before you can couple the cars.

Mr. MARDEN (Fitchburg): I believe that what Mr. ADAMS says about this knuckle is correct. He is using a remarkably good knuckle, strong and tough. I undertook to get some of them, and found they could not supply the Boston & Albany with what they wanted.

Mr. GRIGGS (N. Y. & N. E.): We are very short of links and pins, and the vertical-hook coupler is one great cause. We may receive 10 or 15 cars, and we have got to couple them up, and have to furnish the links and pins to do it. If I had my way, I would not take a car with a vertical hook coupler with any defect whatever; and still further, if I had my way, I would not take one if it was perfect.

Mr. MARDEN: I hope it will not be understood that the New England roads in opposing the vertical hook coupler are not progressive. I don't believe there is a railroad man who would not be glad to see a different form of coupler from the link and pin, and only one form of coupler in use on all our cars. I believe the link and pin coupler is more safe and economical than the vertical-hook.

The men who were responsible for the astounding expressions which we have embalmed above will one and all of them live to be ashamed of their part in them. It would be hard to find a worse example of an almost criminally bigoted spirit. In almost the same breath one man arises to dwell upon the extreme importance of not having couplers which will break, and another to confess that one of his connecting roads has been putting in cast-iron knuckles which were likely to break, and did break "before they were out of the yard." Another man abuses the M. C. B. coupler because it does not open automatically, when he is himself engaged in manufacturing bogus knuckles of such rough make that they cannot open automatically as they otherwise would. He parades a long statement of alleged cost of repairs, which we fully believe to be bogus in spirit, if not in letter, and yet neglects to avail himself of offers from a responsible corporation to take charge of all his repairs and renewals for a small fraction of his alleged yearly cost. Taken as a whole, the course of the New England roads on this question is a pitiful spectacle, the more so that it has been preceded by a long series of similar procedures in regard to other great betterments of railway practice, which the New England roads neglected or opposed like a band of brothers joined, until they were in almost universal use throughout the rest of the country.

PERSONALS.

Major RICHARD A. O'SHEA, civil engineer, died at Greenville, Miss., March 27.

Mr. JOHN M. MACDONALD, mineralogist and mining expert, died at Fort Smith, Ark., March 31.

Mr. W. M. MITCHELL has been appointed one of the members of the Railroad Commission of Kansas.

Mr. A. LIPPERT has been appointed Roadmaster of the New York Central & Hudson River R. R. between Buffalo and Batavia.

Mr. JOHN HICKEY, Master Mechanic of the Milwaukee, Lake Shore & Western Ry., has been appointed Superintendent of Motive Power and Machinery of the Northern Pacific R. R.

Mr. L. D. GODSHALL, M. S., Ph. D., has been appointed Superintendent of the Holden Smelting and Milling Co., of Aspen, Colo.

Mr. S. M. WARD has been appointed General Manager, and Mr. A. TRIPP, Superintendent, of the Charleston, Cincinnati & Chicago R. R.

Mr. J. W. NIER, Consulting Engineer, of the firm of Nier, Hartford & Mitchell, has opened an office at the Equitable Building, St. Louis, Mo. His office at Kansas City has been closed.

Mr. JOHN M. DOUGLAS, of Chicago, Ill., who was President of the Illinois Central R. R. Co. from 1865 to 1871, and from 1873 to 1876, died March 26.

Mr. J. M. JOHNSON, formerly Engineer of the Louisville Bridge & Iron Co., of Louisville, Ky., has been appointed President and Engineer of the company.

Mr. W. M. HUGHES, Assistant General Manager of the Keystone Bridge Co., has been appointed engineer of construction of the Columbian Exposition buildings, with office in the Rookery Building, Chicago, Ill.

Mr. A. J. SWIFT, Chief Engineer of the Delaware & Hudson Canal Co.'s railways, delivered a lecture on "Some Methods of Meeting the Ordinary Requirements of Railway Maintenance," at the Rensselaer Polytechnic Institute, Troy, N. Y., on March 24.

Mr. OTTO RIEZLER, C. E., formerly of the Department of Surveys, Philadelphia, Pa., died at Greytown, Nicaragua, on March 15. Mr. RIEZLER went to Greytown in September, 1890, as mechanical draftsman on the locks being designed for the Nicaragua Canal.

Mr. JAMES W. SHIPMAN, formerly of the New York Bridge Co., and until recently the eastern agent of the Penn Bridge Co., of Beaver Falls, Pa., died in New York, March 25. He had been connected with bridge building for several years and was the author of a book on bridge strains.

NEW PUBLICATIONS.

—*Lessons in Applied Mechanics.* By J. H. COTTERILL, F. R. S., and J. H. SLADE, R. N. London: Macmillan & Co. Cloth, small 12mo; pp. 511; $1.25.

This excellent elementary handbook furnishes another illustration of the superiority in form of English technical books over the average American book of a corresponding class. Instead of being spread out over as much and as heavy paper as possible, it is published in convenient form, with small margins, clear and well-chosen type and good paper, forming a model that ought to be, but rarely is, followed on this side of the Atlantic. One sees at once that symmetry and good taste were carefully studied in making up the plates, and we are glad to add further, what we are not always able to add, that the book is as good in fact as it is in form; a better work in all essentials than some American books of like nature which are sold at $5.

The work opens with an introductory chapter on mensuration and curve tracing. Part I is given up to the elements of theoretical and applied mechanics, and contains two especially good chapters, one on crank efforts and one on fluctuations of energy and speed. Part II. treats of the strength of materials and structures and contains a clear and complete discussion of simple trusses and their design. Part III., the most elementary in the book, is devoted to hydraulics. The scope of the work does not permit of the use of any branches of mechanics above trigonometry, and some of the demonstrations are therefore a little longer than would be the case if the calculus were employed. But this will probably be no drawback to the popularity of the work, which, from its simplicity and clearness, deserves a wide circulation. An admirable feature of the work, moreover, is an abundance of well-chosen examples.

—*Home Study in Architecture.* Instruction by mail conducted by C. POWELL KARR, Architect, 23 Warren St., New York.

This little pamphlet outlines a system of home instruction in architectural drawing and design which seems likely to do good. Therefore we vary from our usual practice by noticing here what can hardly be regarded as a "new publication" in the usual sense of that term.

TRADE PUBLICATIONS.

—*Steam Shovels.*—Catalogue of the Marion Steam Shovel Co., Marion, O., cloth, 9 × 6 ins., pp. 58, illustrated.

This catalogue contains illustrations and descriptions of steam shovels, wrecking cars, ballast unloaders, steam and hand wreckers, ditchers, dredgers, etc.

—*Aveling & Porter's Steam Road Rollers.* Paper, 11 × 8¾ ins.; pp. 50; illustrations. W. C. Oastler, 43 Exchange Place, New York.

A well arranged and well-printed pamphlet containing illustrations and descriptions of the rollers, testimonials from users, specifications for roadways, and some notes and cuts on roads and street railway tracks from ENGINEERING NEWS.

SOCIETY PROCEEDINGS.

Western Railway Club.—At the meeting on March 17 Mr. Gibbs' paper, "Car Lighting" (published in ENGINEERING NEWS March 7 and 14), was discussed. The principal topic was the use of secondary batteries, which Mr. Gibbs said had caused a great deal of trouble on the Chicago, Milwaukee & St. Paul. Besides being so expensive, they were unreliable and wasteful of power, and they were badly used up at the end of three or four months.

The discussion of amendments to the the Rules of Interchange was then taken up, and a large number of changes were proposed and approved. A paper by Mr. Jno. Hickey on "Improvements in Locomotive Boiler Construction" was then read. An abstract is given in another column.

American Society of Civil Engineers.—At the meeting on April 1, Past President Wm. E. Worthen in the chair, the following papers were presented: "The Characteristics of the Ravine du Sud in the Island of Hayti, and Plan for Averting Its Overflow," by Mr J. Foster Crowell; and "The Concrete Sewer at Mt. Vernon, N. Y.," by Mr. Wm. E. Worthen.

A motion was made and carried, requesting the Board of Direction to make arrangements for keeping the rooms of the Society open every night, except Sunday, until 10 P. M. The convention will be held at Lookout Mountain, Tennessee, beginning May 20. The arrangements are not yet completed, but will be announced by circular.

The following candidates have been elected: *Members:* Job Abbott, Chief Engineer, Wheeling Bridge & Terminal Ry., New York, N. Y.; Francis C. Gamble, Victoria, B. C.; Charles A. Wilson, Chief Engineer, Wheeling & Lake Erie Ry., Toledo, O. *Associate Members:* Wm. F. Jordan, Assistant Chief Engineer, Buffalo, Rochester & Pittsburg Ry., Rochester, N. Y.; Levis P. Pennypacker, Broadway Cable Construction Co., New York, N. Y.; Clement I. Walker, Assistant Engineer of Subway Construction, Phœnix Construction Co., New York, N. Y.

Associates: S. G. Comfort, Chester, Pa.; J. R. Dunn, New York, N. Y.; W. C. Oastler, New York, N. Y. *Juniors:* W. E. Belknap, Jersey City, N. J.; E. J. Chibas, Pittsburg, Pa.; L. B. Jenckes, South Manchester, Conn.; J. C. L. Rogge, New York, N. Y.; P. Smith, Jersey City, N. J.; A. H. Wood, National City, Cal. *Fellow:* Edwin D. Adams, New York, N. Y.

American Water-Works Association.—The eleventh annual meeting of the Association will be held at the Continental Hotel, Philadelphia, April 14-17. The meeting promises to be unusually interesting. Tuesday forenoon, April 14, will be taken up with the transaction of business. All the morning sessions open at 10 o'clock, the afternoon sessions at 2:30 o'clock. Tuesday afternoon three papers will be read: "The Beginning and Growth of the Philadelphia Works," by E. Geyelin, Philadelphia; "Riveted Steel Water Pipe," by D. J. R. Duncan, Kirkaldy, Scotland; "The Columbus, O., Water-Works," by A. H. McAlpine, Superintendent. Tuesday evening there will be a reception by the local committee.

At the Wednesday morning's session four papers will be read: "Water-Works Securities," by William Reinecke, St. Louis, Mo.; "Water-Works Notes," by C. B. Brush, Hoboken, N. J.; "Value of Pressure Records in Connection with Water-Works," by Chas. A. Hague, New York; "Water Meters—Cost of Setting and Maintenance," by Edwin Darling, Pawtucket, R. I. Wednesday afternoon four papers will be read as follows: "Is the General Application and Use of Water Meters Advisable in Supplying Potable Water to Consumers? and Will the Practice Prove Remunerative to the Owners of the Works?" by J. Nelson Tubbs, Rochester, N. Y.; "Hydraulic Elevators: Objections to their Use by Water-Works and Advantages to the Public by Their Use," by B. F. Jones, Kansas City, Mo.; "The Necessity of More Accurate Knowledge of the Flow of Water in Pipes, and Some Experiments with Water Hammer," by J. B. Rider, South Norwalk, Conn.; "Importance of a More Uniform System of Water Rates," by H. G. Holden, Nashua, N. H. At the Wednesday evening session there will be a discussion on "Who Should Own the Meter?" a paper read by Mr. J. H. Decker, Salina, Kan., at the Chicago meeting last year. This will be followed by a question box and volunteer papers. Thursday morning papers will be read as follows: "Purification of Water by Metallic Iron," by Dr. Henry Leffman, Philadelphia; "Private vs. Public Water-Works," by E. W. Morse, Haverhill, Mass.; "The Best Form of Contract between Water Companies and Municipalities for Public Water Supply," by J. M. Diven, Elmira, N. Y. The Thursday afternoon session will be at the disposal of the local committee.

The meeting Friday morning will be devoted to business, including the selection of the place of holding the next meeting and the election of officers. The afternoon will be at the disposal of the local committee.

Mr. W. B. Bull, Quincy, Ill., is President of the Association, and Mr. J. M. Diven, Elmira, N. Y., is Secretary. Mr. William Ryle, Paterson, N. J., and Mr. J. L. Ogden, Philadelphia, are chairmen, respectively, of the general and local committees on arrangement.

Since the above was put in type we have been informed that a paper on "Water Motors," by S. E. Babcock, Little Falls, N. Y., was omitted from the printed program. It will be read on Thursday.

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GEO. H. FROST..... .....BUSINESS MANAGER

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Advertising rates, 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

COMING TECHNICAL MEETINGS.

Northwest Railroad Club.—April 4. Secy., H. P. Robinson, St. Paul, Minn.
Engineers' Club of Philadelphia.—April 4. Secy., Howard Murphy, 1122 Girard St.
Civil Engineers' Society of St. Paul.—April 6. Secy., C. L. Annan.
Civil Engineers' Association of Kansas.—April 8. Secy., J. C. Herring, Wichita, Kan.
New England Railroad Club.—April 8, "Air Brakes for Freight Trains." Secy., F. M. Curtis.
Engineers' and Architects' Club of Louisville.—April 8. Secy., G. W. Shaw.
Northwestern Track and Bridge Association.—April 10. Secy., D. W. Meeker, St. Paul, Minn.
Engineers' Club of Duluth.—April 11. Secy., M. W. Lewis.
Engineers' Club of Kansas City.—April 13. Rooms, Baird Building. Secy., H. Goldmark.
Civil Engineers' Club of Cleveland.—April 14. Secy., A. H. Porter, 50 Euclid Ave.
Denver Society of Civil Engineers.—April 14, "Proper Use of Metal in Bridges." Secy., Geo. H. Angell.
Engineering Association of the South.—April 14. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.
Engineers' Club of St. Louis.—April 15. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.
American Water-Works Association.—Annual meeting, April 14-17, Continental Hotel, Philadelphia. Secy., J. M. Diven, Elmira, N. Y.
American Society of Civil Engineers.—April 15. Annual meeting, May 20, at Lookout Mt., Tenn. Secy., Francis Collingwood, 127 E. 23d St., New York.
Engineers' Club of Cincinnati.—April 16. Secy., J. F. Wilson.
New York Railroad Club.—April 16. Rooms, Grisey House. Secy., H. G. Prout.
Western Railway Club.—April 21. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

THE programme of the annual meeting of the American Water-Works Asscciation, given in another column, is an unusually attractive one. Nearly all the most important questions in connection with water-works are to be discussed in some one or more of their phases. As we have said in connection with announcements of previous conventions, it is highly desirable that every water-works official who can possible do so should attend this Philadelphia meeting, and that every water board and company in the country should be representated at it. The questions to be discussed are all live ones, and those who hear the discussions cannot fail to receive valuable suggestions from them. Those unable to be present, however, will find the proceedings very fully reported in this journal.

IT will be seen from an article which appears in another column that there is at least one man in the country who knows who has been manufacturing "home-made M. C. B. knuckles" of cast iron—viz., Mr. J. T. CHAMBERLAIN, Master Car Builder of the Boston & Maine R. R. In some remarks which we reprint *verbatim* Mr. CHAMBERLAIN narrates in detail how some cast-iron knuckles were foisted upon him by "one of his connecting roads," and how they broke almost as soon as they were out of the yard, as might have been expected. We show, also, in another column, that the home fabrication of divers and sundry other parts of another coupler is going on on quite a considerable scale, and that the center of this peculiar industry seems to be Eastern Massachusetts, which, by a singular coincidence, is also the center of a determined opposition to the M. C. B. standard coupler, on the ground that it is not good enough, though we showed last week that over 72,000 miles of road, owning over 702,000 cars, have concluded that it is good enough for them, so that they are putting it on all new cars.*

The question now arises, What have the Massachusetts Railroad Commission done in this matter, and what will they do? We have confidence that they will take prompt measures to put a stop to these procedures. The significant confessions that cast-iron knuckles were in use which we quote from the New England Railroad Club proceedings of Jan. 14 may well have been overlooked by them, as they were by the technical press, as mere single instances of no real significance, but it is now becoming clear that both cast iron and cast steel parts of couplers, fabricated with a gross indifference as to their quality by bitter opponents of the coupler have gone into quite extensive use, and have chiefly, if not wholly, emanated from Eastern Massachusetts. Is it possible under Massachusetts law for some belated railway official who still retains a sneaking preference for the stage coach over the locomotive (and it is but natural to suspect that there may be such) to substitute cast iron for wrought iron or steel in the boiler or connecting rods or coupling links of a locomotive without making himself subject to the terrors of the law? We cannot believe it, and we perceive no difference in principle between such acts and those which have been detected and confessed. Each alike would seem to be what the law defines as "acts evincing a depraved mind, regardless of human life," and punishes by a term in state's prison when serious consequences result.

IT will be remembered that in ENGINEERING NEWS for Aug. 23, 1890, it was stated that, so far as our returns indicated, there were at that time about 60 cities in the United States with a population of 10,000 or over which were unprovided with sewers, while of about 2,000 cities and villages having water-works only 600, at the most, had sewerage systems. Since that time we have been collecting for publication detailed information regarding all the sewerage systems in the United States and Canada. There are a number of cities from which we have yet secured no returns. Whether the officials are ashamed to admit that they have no sewers, or such poor ones, we cannot say. If there are any city engineers who have not received a request for information, which we doubt, a blank form will be sent them upon request; and in order that we may omit no sewered city from our list we shall be greatly obliged if engineers who have been connected with *existing* sewerage systems as designing, constructing or consulting engineers, and contractors who have constructed sewerage systems will favor us by sending a list of the systems with which they have been connected, stating the capacity in which they were or may now be connected with the work.

HARDLY a day passes but we receive at this office requests in regard to books on various special departments of engineering, like the following, which has just reached us:

> I am desirous of obtaining the best work, if there be any, which will give me a sort of history of ocean bar improvements; what various schemes have been tried, and what success has been met with. Is there any such publication in concise form? I would be very grateful for any suggestion from your more extended and intimate knowledge of such publications.

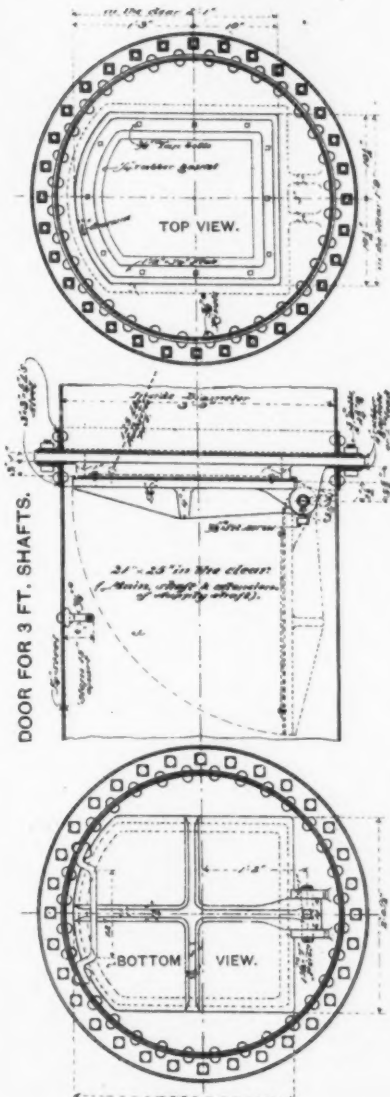
To this and to most other requests of like nature it may be answered: There is no royal road to learning. There is not and there cannot be any one such book. There was probably never yet an engineer who has not at various times felt the need of knowing all there was to be known about some one or another special department of engineering, and who did not feel heartily willing, nay anxious, to send some one a $2 bill, or mayhap so much as a $5 bill, and have some one send him all this information, neatly bound in cloth. Not thus is engineering knowledge gained, and a little reflection ought to teach one that it is in the nature of things impossible that it ever should be thus gained. The *generalities* of engineering may be thus found embalmed in books—arithmetic, algebra, geometry, use of instruments, surveying processes, masonry construction (an art as old as the Pyramids, and not greatly modified since), the general principles on which all the several branches of engineering are based—but when it comes to giving all the latest phases of practice in specific arts, it is in the nature of things impossible to compress these into a volume, and even if an attempt of the kind is partially successful the volume begins to fall behind almost as soon as it is published. Therefore, there is no other way to find out the information extant on any specific subject of this nature except to make a careful and laborious search through current engineering literature, as recorded in official reports, the transactions of engineering societies and the past volumes of engineering journals.

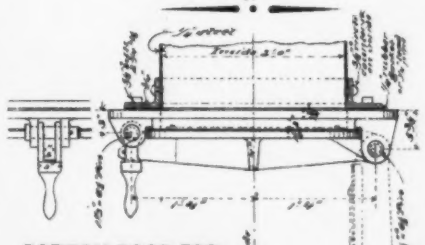
THE Canadian Pacific was the first railway company on this continent to control and operate a through transcontinental line from ocean to ocean. It is now the first of the lines to the Pacific Coast to secure an entrance to New York City. By an arrangement with the New York Central & Hudson River Ry., perfected on March 25, Canadian Pacific passengers and freight will cross the St. Lawrence River by a new bridge to be built at or near Brockville and come down via the Rome, Watertown & Ogdensburg (recently leased to the New York Central) and the West Shore and Hudson River railways to New York. The effect of this new route for freight traffic to the Northwest remains to be seen; but it is quite likely that it will considerably stimulate traffic via the Sault route, and perhaps may cause something of a commotion in western freight rates. The new line will furnish also the most direct route from New York to Canadian points between Montreal and Toronto; and notwithstanding tariffs, it may do a good deal to stimulate international trade.

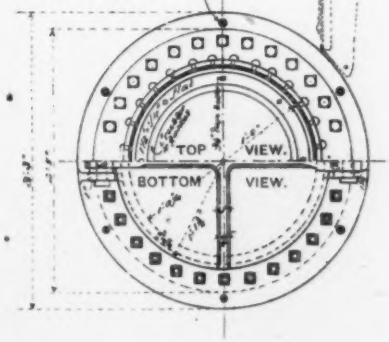
Most of the freight traffic of the Canadian Pacific will be sent over the West Shore; and it is evident that before many years there will be a vast amount of business coming in over the tracks and using the terminals of that unlucky road. Those who sunk their money in that enterprise can have the consolation of reflecting that their views as to the possibilities of railway traffic along the Hudson River were not mistaken. There is traffic enough to support both the railways down that valley,—when under one management. Projectors of railways to parallel an existing road can often show that there is traffic enough to support both lines. What they cannot show is a chance for profits in case the existing road concludes to fight its young rival by rate-cutting until one or the other succumbs.

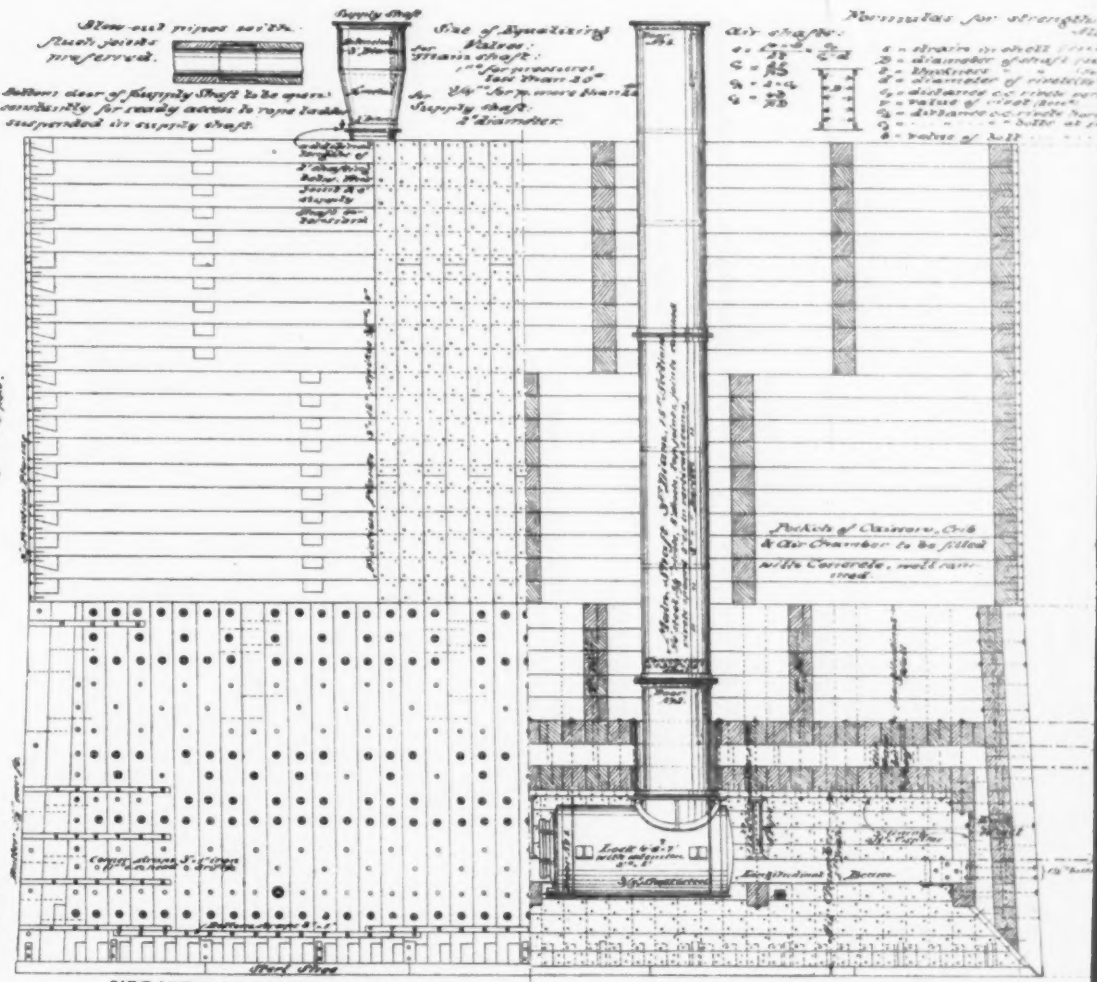
IT will be seen from a news item in another column that the expedition which left New York March 14 for Nicaragua, headed by Hon. WARNER MILLER, President of the Nicaragua Canal Construction Co., and included in which was Mr. D. McN. STAUFFER, of this journal, has met with an unfortunate accident, their steamer having stranded on a small, barren island, about 300 miles from Greytown, in the Caribbean Sea. According to the dispatch, all the passengers, and we trust the crew also, are safe, and two steamers went at once to the rescue, when the news was received but this was not till March 31, whereas the wreck occurred on March 26, so that the party is likely to have 8 to 10 days of a rather novel and probably disagreeable experience. Fortunately they

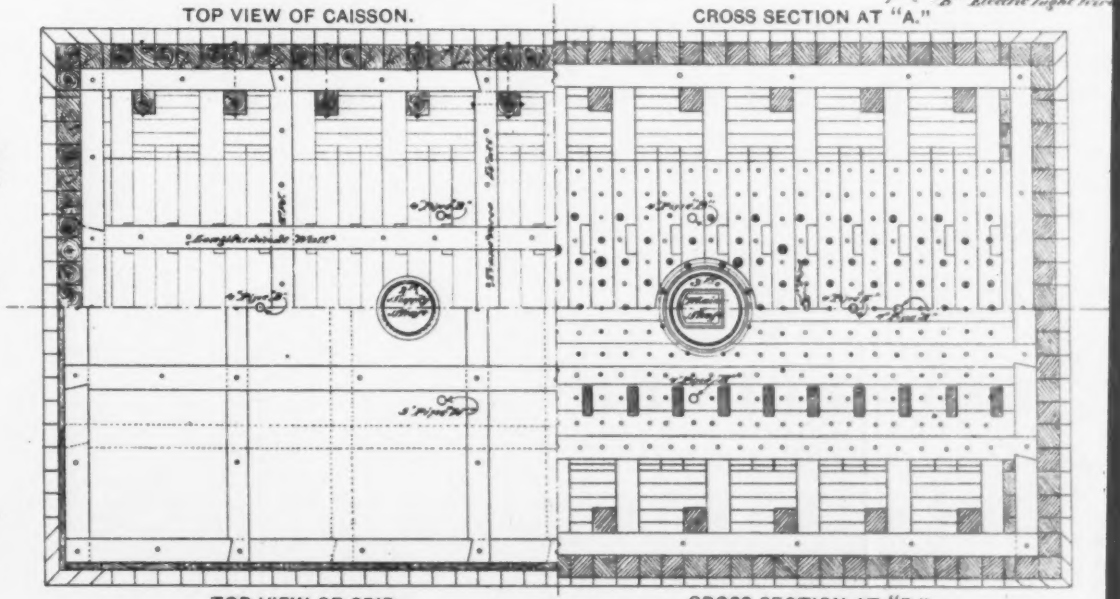
*Of the total of 702,443 cars roads owning 135,000 cars, except certain classes of cars as yet, but these are chiefly the classes which are not interchanged much and are comparatively few in number, so that this trifling exception to the general statement made is of little importance and no significance.


TOP VIEW.
DOOR FOR 3 FT. SHAFTS.
BOTTOM VIEW.


BOTTOM DOOR FOR
2 FT. SUPPLY SHAFT.


TOP VIEW.
BOTTOM VIEW.


SIDE VIEW OF CAISSON AND CRIB.
CROSS SECTION AT CENTER.


TOP VIEW OF CAISSON.
CROSS SECTION AT "A."
TOP VIEW OF CRIB.
CROSS SECTION AT "B."

Formulas for strength of Air Shafts & Air Locks:

All dimensions in inches, all strains in lbs. per sq. inch, assumed air pressure "p" = 60 lbs. per sq. in. (116' of water pressure)

Air Lock.

CENTER.

END VIEW.

CROSS SECTION.

TOP VIEW.

AIR CHAMBER.

SIDE VIEW.

END VIEW.

SIDE VIEW.

VIEW OF CAISSON BEFORE PUTTING ON OUTSIDE VERTICAL TIMBERS.

AT "A."

AT "B."

CROSS SECTION AT "C."

CROSS SECTION AT "D."

of main shafts.-Air pressure "p" = 60 Lbs. p. sq. in." all dimensions in inches, all strains in Lbs. per sq. in.

General Specifications:

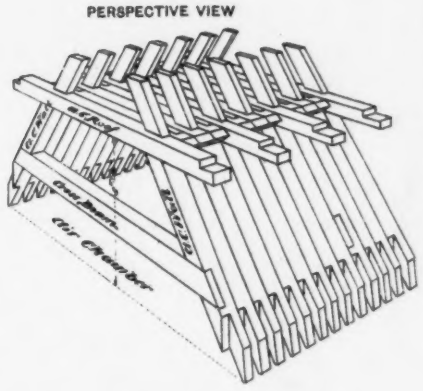
Lumber:
All timbers for caissons & cribs to be 12"×12" timbers.
Lining of air chambers & friction planks 3"×12" plank.

Iron:
All bolts 1" ⌀ except where specified otherwise.
All drift bolts 1" ⌀ general length 21".
Spikes 30"×7"×¾" & 12".
Washers 4"×4"×¾" for 1" ⌀ bolts, 3½" ⌀ diam. & ¼" thick.

Size of air compressors best adapted to caissons is 24" ⌀ diam. × 48" stroke.

AIR CHAMBER FRAME WORK.

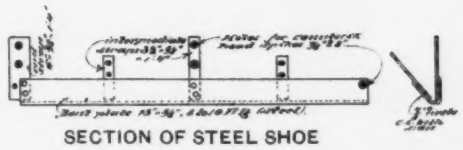
PERSPECTIVE VIEW



SIDE VIEW.

DE VIEW.

UTTING
BERS.



SECTION OF STEEL SHOE

General Directions for Construction of Caissons:

Frame & erect air chamber framework. Drift-bolt "horizontal timbers of a.c. wall to a.c. frame, also roof timbers (2 courses). Spike 3" lining to a.c. roof, & to walls down to cross-beams. Bolt" a.c. roof & walls. Frame longitudinal beams & have them ready for use on cross beams. Drift-bolt inner vertical timbers of end walls to a.c. frame. Build up horizontal timbers of side, end, longitud'l & transverse walls. Add outer vertical timbers of side & end walls. Bolt side & end walls. Put steel shoe in place. Spike on balance of 3" lining of a.c. Attach air lock to a.c. roof. Put in place longitud'l beams, 2" ice rods, & the timbers connecting roof of a.c. with a.c. walls & end walls. Spike on corner straps & bottom straps. Caulk air chamber.

GENERAL DESIGN
OF
CAISSONS AND CRIBS
FOR
QUINDARO BRIDGE
OVER THE MISSOURI RIVER.

THE WYANDOTTE COUNTY BRIDGE & TERMINAL RY. CO.
WILLARD E. WINNER, PRESIDENT. FRANK D. MOORE, CHIEF ENGINEER.
WM. F. WAAG, CHIEF ASSISTANT ENGINEER.

CHAS. HART & SONS, LITH., 84 VESEY ST., N.Y.

are in no danger of freezing to death. There are probably enough turtle eggs to be found, if nothing else, to keep them from starving to death, and our knowledge of the geography of Roncador Island, of which heretofore little has been known, is likely to be considerably enlarged by the investigations of such an intelligent party with ample leisure on their hands. There is no loss without some small gain.

THE Union Bridge Company, of this city, has favored us with a copy of the following luminous inquiry in regard to some proposed new structure which reached it by due course of mail. We give the document *verbatim et literatim*.

.....Minn. Mar. 23, 1891.

Gents.

Please let me know the price of 2 iron bridges 16 ft. square with and without Pillars, for over a Creek.

Resp. Yours

.....

City Eng.

Precisely what was floating through the head of this particular "City Engineer" when he penned this enquiry we do not know. We are gratified to find that he is not a subscriber to this journal, so that we are in no danger of hurting his feelings, and we therefore take the liberty of doubting if he knew himself. The company not unreasonably adds, in forwarding us the enquiry: "The problem presented above is too much for this office to handle in its declining years. Possibly some of your young and ambitious readers may be willing to take it up. We feel as if we had lived in vain in thus being obliged to allow a brilliant opportunity to pass by." We pass the problem along with pleasure.

ANOTHER item from "the wild and woolly West" which reaches us by the same mail, and in this case direct, comes from a "consulting and contracting electrical engineer." It is in the form a well executed annual pass over the "Electric Limited" for the year 1900, the face bearing a picture of the train, and in the back of it is the following inscription:

This train is composed of aluminum cars, and is propelled, heated, and lighted by electricity from the improved storage system, manufactured by THE WESTERN ELECTRICAL STORAGE BATTERY COMPANY; its speed is 250 miles an hour, and when moving at that rate is apparently motionless to the passengers, vibration being completely eliminated by unique and ingeniously designed combination air cushions between wheels and rails of special construction. The weight of this train is greatly reduced by hydrogen gas uniformly distributed throughout each car, and its pointed ends prevent friction in front, and suction in the rear. It is expressly understood and agreed to by the holder of this pass that no claim for damages on account of death, resulting from loss of breath, or heart failure, will be recognized, unless presented to * * * Consulting and Contracting Electrical Engineer, 805 New York Life Building, Kansas City, Mo., U. S. A.

Precisely what is meant by this inscription we leave every one to judge for themselves, adding only that if the "hydrogen gas" weighed nothing and occupied a bulk equal to a circle 10 ft. in diameter for the whole length of the train it would relieve the train of the great weight of 6 lbs. per lin. ft. It is therefore charitable to assume that the card itself is gas, and of interest only as illustrating the kind of gas that is deemed likely to create interest in and business for a "consulting electrical engineer," in the latitude and longitude of Kansas City.

Proposed Innovations in Block Signaling for Tunnels.

The recent collision in the Fourth Avenue tunnel and the wide publicity which has been given to it have brought forth a host of suggestions as to how the signaling system in use there could be improved, most of them, of course, obviously impracticable, but some of them seeming to promise an improvement over the present order of things. The latter class are certainly worth attention from signal engineers, for even the best signaling devices now on the market cannot claim to be perfect, though they are much nearer to perfection than the ordinary run of mechanical devices. In considering any proposed radical changes, however, the essential principles of the block system should be taken into account, and it should be especially noted whether the proposed new methods introduce any new dangers from which the established system is free.

One of the innovations which has been proposed in several different forms is the extension of the signals all along the blocks instead of concentrating them at two points (the home signal and the distant signal). According to a scheme suggested to us by a prominent member of the American Society of Mechanical Engineers, two lines of incandescent lamps would be placed at frequent intervals, say 100 ft. or less, along the whole length of each block. One set of lamps would have plain bulbs, showing the usual white (or yellow) light; the other would have red glass bulbs, and would thus show a red light. The signal operator would simply turn the lighting current into the series of red lamps for danger, or into the series of white lamps for safety. Of course the lamps would be carried out to the distant signal point. A similar line of green lamps might be added. It is argued that an engineer will certainly not run past a whole row of danger signals; or, if he does, some one else may see the red lights and apply the brakes.

At first sight this plan seems an admirable one. Instead of only two signal lights, as at present, there is a whole row, as many as you please; and if an engineer makes a mistake on one, he will not on all. But on closer examination it is apparent that this plan, while promising some advantages, also promises to become a certain source of occasional danger, since it is not in accordance with an essential principle of the block system, which requires that the signaling power should be concentrated to prevent a train from *entering* a block which is still occupied by a train. Usually of course, where the traffic is crowded, trains stop near the end of a block, if at all; but a hundred causes may operate to stop them just after entering a block, and a perfect signaling system should give a train absolute protection as soon as it enters the block and continue until it leaves it. Because the system proposed would probably work well in almost every case is just wherein its danger lies. It is contrary to human nature to expect that an engineer will be as careful not to run past the danger signal at the entrance to a block if he knows that there are other signals every 100 ft. or so ahead, or that the highest officers of the road will require him to be as careful. "Here, Mr. General Manager," says President D—, "I hear constant complaints that trains are delayed in running through the tunnel just when many of my friends are going to and from business. Why can't you run your trains faster? Never mind if your engineers do run past the home signal occasionally when they get on a full head of steam; the train ahead is generally at the end of the block; and with that row of red lights all through, they won't run far past the signal."

This is a perfectly natural method of argument, and one that is too often pursued. "The danger is very small and the gain is certain; therefore we'll run the risk," is the way the average man reasons; and not a few average men hold high offices in railway service. It is thus apparent that the inevitable tendency of any signaling system which introduces cautionary signals of any sort, as instructions to the engineer after he has run by a danger signal at the entrance to the block, is to lessen the force of the home signal and induce both operatives and managers to adopt permissive blocking. We have yet to learn of a reputable signal engineer who believes permissive blocking to be as safe as the absolute system. In fact, it has invariably broken down and proved inadequate for heavy traffic.

In so far as the suggesters of these new systems propose improvements by increasing the number and force of the warnings to the engineer before entrance to the block they are working in the right direction. Arranging an electric current to flash through a series of white or red incandescent lamps to indicate danger or safety *before the block is reached* may be an innovation worth considering; but instead of scattering fifty or more lamps along the whole length of a block, where no engineer has ever any right to be guided by them, concentrate them in the space between the distant and home signals, where every engineer who runs over the line will see them and be warned or reassured by their light. On the same principle that what is everybody's business is nobody's business, what is everywhere signaled is nowhere signaled in a way to *command* attention at the critical moment which is when entering a block.

Whether a given sum to be expended for improved signal lights would give greater results invested in two rows of incandescent lamps, as suggested, between the home and distant signals, or in powerful arc lights placed at these points, is a question on which opinions may differ. On the whole, however, the arc light seems the best signal light for a tunnel line. It gives a white light for safety, while an oil or incandescent lamp gives a yellow light, which is much more easily obscured or given a reddish tinge by smoke. Further, the powerful and concentrated light of the arc lamp penetrates much farther through fog and smoke, and it arrests attention and concentrates it upon the color far more certainly than a much greater amount of light given out by numerous small lamps. The adoption of the arc light, moreover, necessitates no change in existing signaling systems, and removes none of the precautions which extended experience with those systems has shown to be effectual. Practically the only weak point in the visual signal system now in use which the coroner's investigation found, was the dimness and uncertainty of the lights in dense smoke or fog. With this defect remedied, we have yet to learn of any radical change in the present system of visual signals which promises to be of value.

Moreover, the special object of the elaborate modern signal plants is to enable each train to run over the road as safely as if it were the only train on the track, so long as the signals are in its favor and except as restrained by them. This object they have fulfilled for many years and on many roads, with as near approach to perfect safety as human appliances permit. It is, therefore, a mere absurdity to cut down the speed of trains through the Fourth Avenue tunnel to 15 miles per hour, as is now being done in obedience to the Railway Commission's order. If the signals are not at all times distinctly visible, no speed is safe; if they are so visible any speed from zero up is safe, unless it be too great to permit the train to stop before entering the block. The great desideratum is,—make the signals clearly visible. When that is done, the highest attainable safety is assured; and to do it the lights must be strong enough to penetrate through both fog and smoke, since fog and smoke cannot be wholly eliminated by any ventilating plant.

Traction Engines for Heavy Freight Hauling.

The traction engine as a substitute for horses for hauling heavy traffic over common roads has received little attention in this country, except for farm use in some portions of the West. In England, however, the persistent attempts to adapt the steam engine for ordinary road use, many of which antedate the railway era, have been successful to a considerable extent; and, notwithstanding severe restrictions through acts of Parliament and local ordinances, several thousand traction engines are now in use there.

The paper which we publish in another column gives a fairly complete description of the traction

engines now in use in England for road traffic, and it shows that very considerable progress has been made. Much greater progress would have been made, probably, had not the use of traction engines been so hampered by legislation.

There are two main reasons why the use of traction engines has been followed up with much less persistence here than abroad. The first is that all our roads, outside the limits of the cities, have been and still are, for the most part, too soft to admit working a traction engine with profit, while the city pavements are too rough for their ready use. The second reason is the existence of a much smaller field for the use of traction engines here than abroad. A principal use of the traction engine in England is in moving heavy merchandise or machinery from workshops or manufactories to the docks or railways, or even, if the journey be short, to its place of destination. England's total area is less than that of New York and New Jersey combined, and her large manufacturing cities are clustered in small districts; hence a large proportion of English freight traffic is hauled a very short distance. A fact to be considered in close connection with this is that manufacturers there have not as good facilities for railway shipments as in this country. Here there is hardly an important manufactory without spur tracks from a railway line running through its yards. There the laws concerning the laying of railway tracks over private property or in city streets are much more strict and are more rigidly enforced; and the arrangements for convenient shipments which have been made so easily here have not been possible. Of course many important British manufactories have now either railway or water transportation at their doors; but there are still many which have to haul both raw material and finished products a considerable distance to reach a railway line.

Taking these things into consideration, and also the high freight rates of British railways, it is quite easy to see how a manufacturer may find it more economical to make shipments to cities within a radius of a few miles by a traction engine than by the railway.

But because American manufacturers are so well provided with shipping facilities, it does not follow that there is no field for the use of traction engines in this country. It seems altogether likely that a large part of the heavy trucking now done by animal power will eventually be carried on by some form of mechanical motor. Whatever the source of the power, whether steam, gas or electricity be the system employed, some mechanism must transmit the power from the motor to the driving wheels. The perfection of this mechanism and its combination with a suitable running gear has been the chief problem before the designers of the traction engine; their experience and the results they have attained are of direct value in the study of the problem here.

It is probably not generally realized how important in an economic sense is the reduction of the cost of the short-haul traffic now carried on by horses. In no one thing has the engineering profession conferred greater benefits on the human race than in perfecting the art of transportation and reducing the expense of the carriage of goods in their journeys between the producer and consumer. By means of the railway the cost of long-haul traffic has been reduced in some cases below one-half cent per ton mile. The cost of freight transportation by horses, however, has remained nearly stationary. Further reductions will doubtless be made in the cost of carriage by rail; but they promise to be made slowly, and they cannot much affect short-haul traffic. The great opportunity for saving in transportation cost at present lies in the reduction of terminal charges and in the cost of handling off the railway. Better roads can do much to lessen the cost of hauling; but so long as horses are employed, the cost must be very considerable. English experience with traction engines shows a cost of hauling of less than 4 cts. per ton mile, which is claimed to be not more than one-fourth the cost of doing the same work with horses. In this country, or at least in the Eastern States, the cost of hauling with horses probably equals or exceeds the cost in England. The cost of hauling done by the "job" is especially high, the total at both terminals often equaling or exceeding the railway freight bills, for shipments of a hundred miles or so.

Undoubtedly there would be opposition to the use of traction engines on the highways here as in England. It is to be hoped, therefore, that the entering wedge may be so made as not to meet with too much resistance at the start; in other words, that the engines put into general service may, if possible, improve on the English models as regards freedom from noise, smoke and vibration.

It is worth noting, too, that there are probably some opportunities here for the profitable use of traction engines off the highways. Around quarries or in some manufacturing establishments it would perhaps be cheaper in some cases to make gravel roads and use a traction engine and trucks than to lay down the network of narrow-gage tracks commonly employed. In most cases, however, the American practice of using railways for moving material about a manufacturing establishment is doubtless the cheaper and better plan.

CORRESPONDENCE.

The Proposed Filter Plant at Bethel, Conn.

NEW YORK, March 24, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I notice in a published report of a borough meeting at Bethel, Conn., that "ENGINEERING NEWS had severely criticised Mr. RIDER'S plan, but all the objections it raised were satisfactorily explained at the meeting."

Mr. RIDER offered to do all the work for $6,323. It is not stated that any means are provided to clean the filter bed. They may need a filter in the future to purify the befouled water.

F. V. M. HUDSON.

[Our suggestions with regard to possible sources of trouble with the proposed Bethel filter bed, in our issue of March 7, could hardly be called severe criticism. We simply pointed out that Mr. RIDER'S plan departed to some extent from established precedents in engineering practice and was counter to the prevailing opinions of the best authorities. Of course these do not have much weight with the voters at a borough meeting.—ED. ENG. NEWS.]

Better Circulation in Locomotive Boilers.

ST. LOUIS, March 27, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In an editorial article on pages 277 and 278 of the NEWS you show the advantages to be obtained by securing a better circulation of water around the fire-box in boilers of the locomotive type. Your arguments are certainly convincing, especially in the matter of increased life of staybolts. Better circulation would doubtless lengthen the life of fire-box and staybolts. Better circulation would unquestionably increase the rate of evaporation for fire-box heating surface.

Would this latter change, however, be a gain or a loss? A higher rate of evaporation for fire-box surface means an increased capacity for the boiler. A better circulation, a higher rate of evaporation, a cooler fire-box sheet means a cooler furnace, or a lower temperature of combustion.

With a lower furnace temperature we get less complete combustion and more of our gaseous fuel escapes to the stack unburned. It is perhaps the very fact that we have such imperfect circulation around the fire-box that keeps the efficiency of our locomotive boilers up to their present standard.

The bubbles of steam entangled by the impeded circulation protect the hot sheet from the cooling water. The sheet, and therefore the wall of the furnace, is worked at the highest temperature which practice has shown to be safe. The gases thus have time to burn before the flame is extinguished by contact with the cool surface of the tubes.

If this diagnosis is correct, we should move circumspectly in the matter of increasing the circulation around the fire-box. What we gain in capacity and durability we may lose in efficiency. Save your metal and you waste your fuel.

The question is one of great interest to me, as I have just now under consideration the design of a high-pressure fire-box boiler for stationary use.

S. BENT RUSSELL.

[The maintenance of "an igniting temperature" is, as our correspondent says, necessary to combustion. His question is, whether the cooling of the side sheets by better circulation in the water space could cool the fire-box below the igniting temperature. Evidently the cooling of the side sheets could not reduce the temperature of the whole furnace below the igniting point, since the temperature of the central part of a locomotive fire-box is generally as high as 2,000° to 4,000° Fah. Even a heavy charge of fresh coal, while it reduces the temperature far beyond what any cooling of the furnace plates could effect, cannot put out the whole fire.

Whether it is possible that the additional cooling of the furnace plates due to better circulation in the boiler could have any appreciable effect in reducing currents of gas at the sides of the furnace below the igniting temperature is somewhat a matter of conjecture; but all the probabilities seem against it. The side plates receive most of their heat by radiation from the whole furnace, and not by actual convection and conduction of the hot gases. Again, in most locomotive furnaces burning bituminous coal at the present day, a firebrick arch is used, which deflects and mixes the gas currents from all parts of the fire-box and ignites any cool currents. Even if there should be a small amount of combustible gas cooled to a temperature of, say, 600°, in passing over the side sheets, it would probably be heated, mixed with air, and burned before it reached the tubes. As a matter of fact, the loss of heat from a locomotive boiler, by imperfect combustion, is probably never more than one-fourth of the loss in the gases escaping from the chimney; and since the general adoption of the brick arch, it is probably, with decent firing, of little practical importance.

Possibly our correspondent's supposition that boiler heating surface may be made too efficient for economy would prove true in a stationary boiler furnace working under natural draft, and, of course, at a low temperature compared with the locomotive. It is very much more likely, however, that the much longer time permitted for combustion in such a furnace would give the gases time to burn before entering the tubes.—ED. ENG. NEWS.]

Locomotive Head Resistance.

CLARKSVILLE, Tenn., March 16, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I see from late scientific publications that recent experiments on French railways has proved that the atmospheric pressure or resistance to high speed locomotives amounts, in some cases, to almost one-half the total resistance. This is a very startling statement, and I would like to investigate it further. Will you kindly inform me where I could obtain information relating to this subject of atmospheric resistance to locomotives? Have you at any time published in your paper an article bearing upon this subject? W. M. V.

[The subject is still involved in obscurity, but the statement quoted is in substance correct. The information on the subject is scattered through technical literature, and we have published many articles relating to it more or less directly, which can be found by our correspondent as well as ourselves on searching through our back files, or examining our forthcoming General Index. Most of the more important information on this head is summarized in Mr. WELLINGTON'S treatise on "The Economic Theory of Railway Location." Since that treatise was published in 1887, little of importance has appeared, and what has appeared is merely confirmatory of old results.—ED. ENG. NEWS.]

Baltimore Engineering News.

BALTIMORE, Md., March 24, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: There are numerous extensive improvements in progress here, including the Equitable Building, 10 stories high, CHAS. E. CARSON, Architect; the Baltimore Belt R.R., for which 7,000 ft. of tunnel is being driven under the direction of SAMUEL REA, Chief Engineer, and Ryan & McDonald, contractors; and the Baltimore Traction Co.'s lines, of which about 8 miles of cable conduit of the latest steel lined pattern have been nearly completed under the direction of Chief Engineer FRANK H. HAMBLETON and contractor E. E. Smith.

The City Commissioner, Capt. A. E. SMYTH, is completing the new Light St. bridge with a draw span designed by

CHAS. H. LATROBE and built by the King Bridge Co; the South Monroe St. bridge on the designs of F. H SMITH, with the Youngstown Bridge Co. as contractors, and the big Cross St. tunnel for sewers; also projecting a number of new sewers and waiting on the law officers to devise a new form of ordinance for paving assessments to meet recent legal decisions before entering on a large lot of much needed street improvements.

The Water Department, under Chief Engineer R. K. MARTIN, is shaping up a big season's work in laying mains to get out as much as possible of the 125 million galls. of daily water supply which the new Gunpowder tunnel sends into the reservoirs from its 6¼ miles of underground journey.

The Park Board, under Chief Engineer C. H. LATROBE, is pushing the extension of Patterson Park, with its new lake and pavilions and also its new iron observatory tower. There is also a bill before councils to authorize a complete resurvey of the entire city and suburbs.

The Harbor Board, under Chief Engineer N. H. HUTTON, is getting ready to put in a suction dredge, or something similar, that will pass under the many fixed bridges over Jones' Falls and dredge out its foul bottom, and he is also keeping the harbor dredged out to the full 27 ft., while Col. CRAIGHILL is widening out the channel to 600 ft. width by 27 ft. depth, connecting the harbor with Chesapeake Bay.

The Pennsylvania Steel Co. is making extensive improvements at Steelton. The South Baltimore Car Co. is turning out 18 cars per day; the South Baltimore Foundry, the Ryan & McDonald Mfg. Co. and the new glass works are in full blast, and an electric railway is being surveyed.

F. H. S.

Engineering News from San Francisco.

SAN FRANCISCO, Cal., March 24, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: By whatever route one approaches this city (unless it be by the coast line of the Southern Pacific, which has its station near the heart of the business district), one comes in contact at once with that which makes San Francisco the commercial and maritime metropolis of this coast—its beautiful bay, with the hundreds of vessels lying at the piers. Whether arriving by steamer or crossing the bay by ferry from an overland train, you are landed within a square or two of the foot of Market St., the main artery of the city, and more to it than Broadway is to New York or Washington St. to Boston. It crosses nearly all the principal streets at an angle, and either by the Market St. cable cars or by some of the lines leaving it at every square, every part of the city can be reached.

Heretofore most of the ships for this coast have been built in the East and brought around the Cape, owing to the cheaper bids from the Eastern companies; but it has recently proved that, including the cost of the trip and the repairs incurred by bad weather around the Cape, the total cost is more than if built here, and after this more work will be done at home.

The harbor front has been very much enlarged of late years by the building of the sea wall; and in January last the building of another section 1,000 ft. long was commenced, which will add much valuable room for shipping when completed and filled in.

A belt road is being built along the harbor front by the state, extending from Powell to Washington Sts. The track laying was begun Jan. 30 near the Lombard St. freight slip, which is just being completed. The latter is 490 ft. in length, with a 90-ft. apron and 35 ft. of water at low tide. It will thus allow the largest vessels alongside.

The passenger travel across the bay to Oakland, Alameda and Berkeley is enormous, as many people doing business in 'Frisco live across the bay. Some time during the next decade the problem of a bridge across will be solved. The traffic at present is accommodated by the railway ferries. With shallow water to Goat Island, the railways would have crossed that far before this had it not been government property.

Among the improvements at present under way by the government is a new steel drawbridge of 315 ft. span across the tidal canal, Oakland harbor; and as Col. MENDELL, the engineer in charge, based his call for proposals on Cooper's specifications, a very substantial structure may be expected.

The bridge companies here report bridge building very quiet, but as all of them engage in wharf building, pile driving and similar work, they are more or less busy. The San Francisco Bridge Co., the largest concern on the coast, does a large amount of railway building and contract work, and is now engaged on the canal for the Central Irrigation District of Colusa County, having designed and patented an excavator especially for this work. This machine spans the canal from bank to bank, running on a rail on each side. The arm carrying the buckets travels across from one side to the other, while the entire machine moves longitudinally on the track; it cuts a ditch 100 ft. wide by 20 ft. deep at the rate of a half mile per month.

The office of the King Bridge Co., of Cleveland, is in charge of Col. G. A. EBERHARDT, who is preparing to do an extensive business during the coming year. It has had an office here for many years and has done work in almost every county in the state.

The Pacific Bridge Co. is the only company which builds suspension bridges extensively; and they have built some of 400 ft. span for carrying timber flumes across the mountain valleys. A number of bridges in the Sandwich Islands, some work now under way in China, and the recent completion of an iron pier at Ocos, Central America, shows the extent of the company's business territory.

Among the best pieces of bridge work on the coast are the Downey Ave. and First St. bridges in Los Angeles, built by the California Bridge Co. of this city. Among other bridges contracted for by them, but designed by Mr. A. D. OTTEWELL, Consulting Engineer, is the steel drawbridge on the San Francisco & North Pacific R. R. at Petaluma (illustrated in ENGINEERING NEWS of Oct. 13, 1888), of 227 ft. span. A Baltimore truss bridge built by the company near Salinas, Monterey Co., is of two spans of 300 ft. each, and is doubtless about the maximum size that has been built in combination work. The combination cantilever over the North Umpqua River in Oregon has a river span of 290 ft., with shore arms of 147 ft., and, aside from being a novelty in bridge construction, is the only structure of this type on the coast, excepting the Fraser River cantilever.

The majority of the coast engineers have come here from the far East, adapting as far as possible Eastern ideas to Western material. Having an abundance of good timber, and of unlimited length, fewer panels have been used, and longer joists. The engineer back East who clings to 12 ft. or 13 ft. panels, either from choice or from inability to obtain long timber, would be surprised to find that here panels of 25 ft. are not at all uncommon.

C. E. FOWLER.

The Efficiency of Centrifugal Pumps.

LOCK THREE, Ala., March 19, 1891.

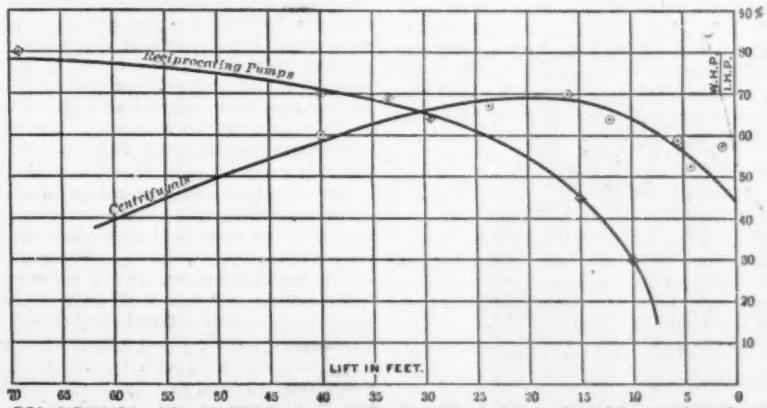
TO THE EDITOR OF ENGINEERING NEWS:

SIR—I have had occasion to look into the subject of centrifugal pumps, and find all available authorities very indefinite on the subject of "lift." They all agree that the centrifugal is one of the most economical pumps for low lifts, but fail to state the practical limit of the lift.

The presumption is, from what I can gather, that somewhere about 25 ft. is that limit. The article on centrifugal pumps in your issue of Jan. 31 seems to indicate, however, that the practical limit is much greater than that stated above.

Will you kindly clear up this uncertainty through the columns of your journal? X. Y. Z.

[The article referred to is by a manufacturer of centrifugal pumps, and its statements are entitled to much weight. Accurate tests of centrifugal-pump efficiencies have not been very numerous. A paper read by Mr. W. O. WEBBER before the American Society of Mechanical Engineers five years ago gave the following diagram of the efficiencies of centrifugal and reciprocating pumps; the curve for the latter class was plotted with results obtained from published tests of the best types of pumping engines. The curve for the centrifugal pumps was plotted from the results of special tests. Mr. JOHN RICHARDS states that the efficiency remains nearly constant for heads above 60 ft. It will be seen that centrifugal pumps are much more efficient for very low heads than reciprocating pumps. For high heads they are little used, not so much because of non-efficiency as because of the higher efficiency of reciprocating pumps.



THE EFFICIENCIES OF CENTRIFUGAL AND RECIPROCATING PUMPS, WORKING UNDER VARIOUS HEADS.

Mr. WEBBER comments on the diagram as follows:

The work done in taking water from one level and placing it at a higher level is divided into three important parts—(a) Lifting a certain number of gallons or pounds a given number of feet; (b) overcoming the friction of water through the pipes and pump; (c) overcoming the friction of the moving parts of the pump and engine due to the load imposed.

The reason why we are able to obtain such high efficiencies with reciprocating pumps at high lifts is because the first factor is so large a proportion of the work done: for if a certain number of gallons is to be raised in a given time to a given height, our only hope for high efficiencies lies in making the friction of water through pipes and pump, as well as the friction of the pump itself, a minimum. Here is where a change in style of pumps on low lifts is taking place. The water, in passing through or passing over the disk of a centrifugal pump, meets with almost no resistance, in the shape of valves to be opened, corners to be turned sharply, and contracted passages, so often found in the common piston pump.

It should be said that there are other important advantages (and some disadvantages) of the centrifugal pump which must be taken into account, as well as the efficiency, in deciding upon its use or non-use under high heads. The first cost of a centrifugal pump is given approximately by Mr. WEBBER as but four-tenths the cost of a piston pump to perform the same duty.—ED. ENG. NEWS.]

Notes and Queries.

E. N. P. asks for "some good work on Levee Construction." We know of no book on the subject. Some data may be found in the Reports of the Chief of Engineers, U. S. A., and more or less has been published in ENGINEERING NEWS.

M. W. asks: "Through what source can I ascertain the number of miles of iron bridges and viaducts on railways in the United States?" The best and only available statistics on the subject give the total as 390 miles. For more detailed information see Cooper's "American Railroad Bridges."

J. B. W. asks: Can you inform me as to the price of a testing machine for timber, and where such a machine can be purchased; also as to whether any reliable tests have ever been made of Oregon fir?—Fairbanks & Co. of New York, make excellent testing machines, and there are various other makes which are well spoken of upon the market. The Oregon fir was tested for E. A. Littlefield, C. E., Cascade Locks, Ore., in 1881 or there abouts, at the government testing laboratory, Watertown Arsenal, Mass. It is probable that Mr. Littlefield still has the official report for which he paid.

Perils of a Brakeman's Life.

According to a statement in a daily paper, a brakeman named JOHN HAYES, who has been in the employ of the Albany & Susquehanna R. R. for 8 years, has spent more than 5 years of that time in hospital, suffering from injuries received in the discharge of his duties. Twice he has been caught between the bumpers while coupling freight cars, in one case having several ribs broken, and has had his right hand badly crushed. On several occasions he has sustained injuries more or less severe in collisions and derailments. Some weeks ago while standing on the car of a freight train the car jumped the track and went down the bank, throwing the brakeman on his head and shoulders on the frozen ground. He is now in hospital with concussion of the brain, but the doctors say that he has a chance for life yet. This man must have had singularly hard luck, but his case shows what risks are run by brakemen. The general introduction of automatic couplers and continuous brakes for freight trains will eventually eliminate this class of accidents.

Maslin's Automatic Steam Vacuum Pump.

The steam vacuum pump was originally invented by SAVERY, and was one of the earliest devices for applying the force of steam to the raising of water. Its great wastefulness in the use of steam soon caused it to be superseded by more economical

Fig. 1. Maslin's Automatic Steam Vacuum Pump.

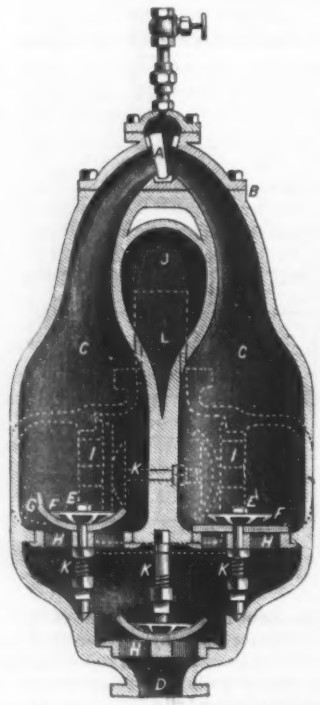


Fig. 2. Vertical Section of Maslin's Pump.

pumps, and it was not until many years had elapsed that in a new and improved form, bearing no resemblance to SAVERY'S invention, it was again brought into use. It is now pretty well known to engineers as among the best types of pump for use where the water to be raised is foul or contains considerable solid matter, where the work performed is intermittent or temporary, or where the placing of an ordinary pump is difficult or expensive.

The vacuum pump illustrated in the accompanying engravings is being put on the market by John Maslin & Son, Jersey City, N. J., and many advantages are claimed for it, especially in the matter of ease of repairs. These pumps are frequently worked suspended by a chain, or in places where it is very difficult to get at them. In pumping water containing gravel or other solid matter it occasionally happens that a stone or some other obstruction will get caught under the valve, preventing it from closing, and making necessary the opening of the pump. In gritty water, too, the wear on valves and valve seats necessitates their frequent renewal. The pump illustrated is so made that all the valves can be got at with very little trouble. The handhole cover is held by a crowfoot (see Fig. 1). A turn or two with a wrench loosens the nut which holds this crowfoot in place, and the cover can then be turned and removed. Through this opening the suction and discharge valves and their seats can be examined, adjusted or removed if necessary. The valve-seats and valves are easily removed by turning the nut on the screwed rod, which holds both valve and seat in place, shown in Fig. 2.

The valves used in these pumps are rubber discs, held fast at the center, but free to rise at the edges, as seen. By a recent improvement these valves are thinned between the center and the edge, thus reducing the strain on the rubber by the bending, and lessening its liability to fail by cracking.

An important detail of the operation of steam vacuum pumps is the correct adjustment of the air valves. To show the importance of this adjustment a brief explanation of the pump's method of working is necessary. When the valve *A* in the neck of the pump is in the position shown in Fig. 2, suppose the right hand chamber to be full of water. The steam from the pipe at the top flows down through the neck, and, pressing on the water, forces it out of this chamber into the delivery pipe (shown by dotted lines). While this is going on, the left-hand chamber, which was filled with steam at the former stroke, rapidly fills with water, drawn in by the vacuum formed by the condensation of the steam. At the same time a small air valve near the neck of the chamber permits a small quantity of air to be sucked in. The water rushes up with considerable velocity, and as the chamber becomes nearly full a pressure is exerted on the valve *A* by the inertia of the water. At the same time the pressure in the left hand chamber has fallen, owing to the rapid condensation of the steam by the cold walls of the chamber and its escape at the delivery pipe. The valve *A* is thus tipped to its opposite position and the steam flows into the chamber on the left, forcing the water out at the delivery pipe. The small amount of air drawn in through the air cock acts as a cushion to make the action of the pump smooth and free from shocks, and also to economize the steam. The air acts as a non-conducting piston between the surface of the cold water and the current of hot steam.

The adjustment of this air valve greatly influences the smooth and economical working of the pump. If too much air is admitted, the capacity of the pump is lessened, the steam being spent in forcing air instead of water. If too little air is admitted, the pump will pound at each stroke and the steam consumption will be increased because of the direct contact of the steam with the water.

The air-valve used with the Maslin pump is of simple construction, and by it the amount of air admitted may be accurately regulated.

The prices of steam vacuum pumps have been largely reduced since the expiration of some of the principal patents. The list price for a Maslin pump with a capacity of 3,900 galls. per hour against a head of 25 ft. is $100, and a 6 HP. boiler is required to run it. A pump with a capacity of 25,500 galls. per hour against a similar head requires a 15 HP. boiler and costs $275.

For many uses to which vacuum pumps are put, the question of their economy in the use of fuel is of small importance, compared with their convenience and ability to work under conditions where ordinary pumps would fail. For many uses, however, the amount of fuel consumed is a matter of considerable importance, and it is to be regretted that so few reliable figures on this point are available. A paper read by J. FOSTER FLAGG before the American Society of Civil Engineers in 1875 described careful experiments on different types of steam vacuum pumps. These experiments showed a coal consumption of about 40 lbs. per HP. hour. Many improvements have been made in the pumps since that time, and those now on the market are doubtless much less wasteful of steam. As near as can be calculated from the manufacturers' statements of capacities and boiler power required, about half the fuel consumption per HP. above noted is now sufficient with the larger sizes of pumps. More exact figures are greatly to be desired; and if any of our correspondents have made any recent tests of these pumps we shall be glad to publish the particulars. The subject would be an excellent one for a graduating thesis, since the experiments required are so simple that any bright candidate for graduation from a course in mechanical engineering should be able to carry them out successfully.

The Sewerage System of Atlanta, Ga.

Like most of our older cities, Atlanta has, until recently, built its sewers in a haphazard way. In 1885 the Board of Health called attention to the lack of system in the city's sewers. In 1888 sewerage work was placed in charge of City Engineer R. M. CLAYTON, and under his direction extensive improvements have been inaugurated. In December, 1890, the Sewer Committee, of which Mr. JACOB HAAS is chairman, received a careful report upon a system of sewerage from Mr. RUDOLPH HERING, C. E., of New York. From that report, which is included in the city reports for 1890, and is printed, together with Mr. HERING'S report upon the Atlanta Water Supply, we abstract the matter which is of most general interest.

The topography of the city and the problems involved in planning a sewerage system for the city are best stated by the following quotation from Mr. HERING'S report:

> The city of Atlanta is situated upon a ridge which divides the waters of the Atlantic Ocean from those of the Gulf. This ridge is narrow and the ground slopes from it with an irregular fall of several feet per hundred, northward toward the Chattahoochee River and southward toward the Ocmulgee River. The slope affords good natural drainage. Within the city limits, which form a circle of three miles in diameter, are the headwaters of a number of brooks, which remain small until after they have passed far below the inhabited territory. On one hand these brooks, because small, are easily fouled by sewage; on the other hand, they do not require very large artificial sewers or drains to inclose and carry off all the water that will come to them. Therefore, they have generally been inclosed when flowing through populated territory.
>
> Of the city's population over 40,000 are supplied with water at the rate of about 45 galls. per head per day, thus causing considerable sewage. Much of the territory of the city is well built up and many of the streets are paved. The large areas thus being made impervious to water are increasing the quantity of rainwater reaching the brooks considerably.
>
> When fouling and frequent flooding made it necessary to inclose the water courses the inclosing sewers were constructed without reference to sanitary requirements. Rough stone work, flat bottoms and irregular grades and sizes are their characteristic features. They have, therefore, caused considerable nuisances at times.
>
> When these water courses were too large to inclose at a moderate expense, so-called sanitary sewers were built down several of the valleys to receive only the foul water which the ordinary sewers brought to them and to discharge it as far down the brook as was deemed advisable. This expedient was a good one and it may be continued with advantage in the outskirts of the city when sufficient funds are available for the large sewers inclosing the brooks.
>
> In preparing the design for the new system, I have endeavored to utilize all the old existing works as far as practicable. This has been done whenever they were in a fairly good condition. In some cases the alignment of the system on this account is not what it would have been if none of the previous works were utilized. It is necessary in some instances to remodel the sewers by substituting a new bottom, which will give a smooth and regular surface for the sewage to flow upon and concentrate the flow as much as possible.

After making the above general statement, Mr. HERING discusses the disposal of sewage, the separate and combined systems of sewers and the five main sewerage districts into which the city is naturally divided. The latter drain toward the outer part of the city. Ultimately some mode of purification, or partial purification, may be necessary; but as the territory along the brooks leaving the city is not now inhabited, it is proposed to turn the sewage into them, for the present, at least. Eventually a

purification plant for each sewerage district may be desirable or necessary. Since provision must be made for the removal of storm water from the greater part of the city, and purification is not to be employed at present, the combined system is recommended for all but a small area of the city.

The size of the proposed sewers is based on an assumed maximum rainfall of 3½ ins. per hour, with an allowance of a discharge into the sewers of 87½ cu. ft. per second for an area of 50 acres. Beyond this area the amount of sewage provided for is assumed to increase according to the BURKLI-ZIEGLER formula. The general maximum velocity of flow in the sewers was assumed at 10 ft. per second, when running half full. This velocity could be increased to 12 ft. provided the material of which the sewers are constructed is hard enough to prevent too rapid wearing. The assumed minimum velocity was 3 ft. per second. The relation of slope and roughness to velocity was determined by KUTTER's formula, the coefficient of roughness being 0.013, which should be increased to 0.015 or 0.017, when old sewers are incorporated in the system. If only sewage and roof water enter the sewer for one short block 10 ins. is the minimum size, but when street water enters this should be increased to 10 ins.

Mr. HERING states that the use of "half pipes" may prove to be of special benefit in repairing the old, flat-bottom sewers in Atlanta. These half pipes are made in the same way as whole pipes, but have a groove on each side sufficiently deep to admit of being broken in halves by means of a smart blow. Many miles of old sewers in New York have been greatly improved by using half pipes.

Owing to the steep grades on some of the Atlanta sewers Mr. HERING advises drops, where needed, to prevent too rapid a flow and the consequent wear of the sewers. In case the drop is not more than 4 ft. it may be vertical. If more than 4 ft., two drops, a succession of stone steps, or a curved fall may be used. The latter may have a drop of 30 ft., but should be flat enough to allow the sewage to remain upon the masonry, instead of leaping all the way down.

The conditions in Atlanta are such that, with the system as recommended in the report, hand flushing of branch sewers once a week is all that is deemed necessary. Mr. HERING recommends that this be effected from manholes at the head of branch sewers which shall be filled with water, then have their contents discharged by opening a valve at their bottom.

Mr. HERING was asked to outline the various methods of raising money to pay for sewers, and names and discusses them briefly under three heads, as follows: Loans; loans or general taxation for main sewers, and assessments upon abutting property for branch sewers; assessments upon abutting property for the whole system. An unusual form of assessment, one which is rarely practiced in this country, if official reports from many cities can be relied upon, is to levy an annual sewer tax for both construction and maintenance proportionate to the water tax. This method is thought by some to be especially adapted to cities "where there are large properties with few buildings, and where the frontage tax would be out of proportion to the benefit derived from the sewers." It is obvious that this plan would be advantageous in some cities, but it presupposes public ownership of the water-works. Some facts regarding means of paying for sewers and other public works in ten of our large cities were given in ENGINEERING NEWS for March 21, 1890, p. 281.

Filtration at Atlanta, Ga.

The annual report of the Water Commissioners of Atlanta, Ga., is looked for each year by all interested in the subject of filtration. The city has in use a Hyatt filtering plant with a contract capacity, which has been exceeded, of 3,000,000 galls. a day. The plant was put in operation in November, 1887, and has proved satisfactory.

The following incident, taken from the report of Superintendent W. G. RICHARDS, is interesting as an unusual accident, and as showing the action of an excessive amount of alum upon wrought-iron service pipes:

At about 2 o'clock on the morning of July 10 the oil refinery at the headwaters of the Harden Branch was destroyed by fire, and upward of 200,000 galls of cotton-seed oil were discharged into the reservoir. This gave much trouble and annoyance. The water being below the overflow, the oil had to be taken from the surface with pumps and skimmers, which required several days to elapse before the oil was removed, and from the shifting winds the oil was deposited upon the banks all around the reservoir. This deposit was removed and carted off under the direction of Chief Sanitary Inspector VEAL. The work was thoroughly done, and when completed the reservoir presented a better appearance than for several years past. During the period the oil was on the surface not a drop found its way into the pumps, though, to prevent its doing so, and also to prevent clogging the filters, it was found necessary to take the water from valves very near the bottom of the reservoir. Much of the mud deposit was taken into the filters, which could only be removed by the use of a much greater quantity of alum than is usually used in filtering. The mud contains a large amount of sulphureted hydrogen. The filters effectually removed the mud, but much of the gas found its way into the city water mains. Another fault was that the extraordinary quantity of alum acted upon the wrought-iron service pipes and liberated a quantity of oxide of iron, which was seen on the surface of water drawn into bathtubs and other vessels. The iron was, by many persons, thought to be oil. The iron and gas brought forth a sort of general condemnation of the quality of the water. However, like all troubles, it ended with the lapse of time. As soon as it was considered safe to do so, the water was again taken from near the surface, and the water in the city was again pronounced good for man, beast and boiler.

The amount of alum used at the time of the accident is not given in the report, but in the report of the city Board of Health for the year it is stated that some days after the accident the amount of alum used per day was reduced from 1½ bbls. to less than ½ bbl.

Further information regarding the accident is given in the last report of the Board of Health, from which some additional facts are abstracted. There were discharged 4,200 bbls. of oil, 200 bbls. of soap stock, or crude oil, and 6,000 bbls. of caustic soda. A boom was thrown across the reservoir and the mill company recovered about 2,000 bbls. of oil. As the water in the reservoir was lowered the oil left upon the banks of the storage reservoir, the report states, appeared to undergo decomposition, a process which was facilitated by the admixture of crude vegetable matter.

Under the direction of Mr. J. M. MCCANDLESS, Chemist for the city, air under pressure was forced into the water at the intake, before the water passed to the filters. The air pump was started July 29, 19 days after the accident, and the results seem to have been gratifying.

The following analyses were made Aug. 7, just four weeks after the accident:

	Grains per gall.		Parts per million.	
Sample from:	Total solids.	Sodium chloride.	Free ammonia.	Albuminoid ammonia.
Harden's Branch, above reservoir, before filtration...	14.20	0.37	0.02	0.33
Intake pipe of reservoir, before filtration.....	10.50	0.45	0.02	0.28
Clear water basin, after filtration....	4.70	0.43	0.05	0.04
Faucet in city, after filteration.....	4.70	0.43	0.05	0.04

It appears from the above that the water was considerably improved by standing in the reservoir, the solid matter being reduced from 14.2 to 10.5 grains per gall. Filtration reduced the solid matter to 4.7 parts per gall., and otherwise greatly improved the water, as is shown.

Superintendent RICHARDS states that the filters did their work well through the year, as shown by the uninterrupted purity of the water. Repairs to the filters were very few and unimportant.

The total recorded pumpage for the year was 861,241,100 galls., or a daily average of 2,359,590 galls. All this water was filtered, and enough in addition, of which no record was kept, to supply at night the boilers of a 2,000,000-gall. engine. The total amount of alum used during the year was 92,390 lbs., or 532,166,400 grains. This is a daily average of 253.12 lbs., or 1,457,971 grain. The amount of alum per gallon was 0.617 grains, an amount considerably larger than would have been used if the accident described above had not happened. In fact, the superintendent states that the average amount per gallon would have been about one-half grain had not the accident occurred.

The total cost of filtration for the year was $3,292.82, or $3.83 per million, or 0.383 cent per thousand galls. This includes $821.25 as the amount paid attendants. As the rate of wages was $2.25 per day, it is evident that the exact cost for attendance is not known, and that an average of one man's time throughout the year has been allowed. In explanation, it should be added that the filtering plant is located at the pumping station, and of course constant attendance upon the filters is not necessary.

The Proposed East River Tunnel.

Referring to the system adopted by CHARLES M. JACOBS, C. E., for the proposed tunnel under the East River, which was illustrated in the ENGINEERING NEWS of March 14, Mr. LOUIS STERNE, who was associated with Mr. GREATHEAD in driving the Southwark Tunnel, at London, stated recently to our Boston correspondent that any form of tunnel having a brick lining would be extremely objectionable, and he regarded the plan proposed as almost, if not quite, impracticable. He would leave it to any mining engineer to say whether a tunnel with excavation 60 ft. wide and 32 ft. high, lined with brick 36 to 42 ins. thick, would be likely to stand. The experience at the Severn Tunnel was that with a pressure of but 53¼ lbs. per sq. in. the bricks were fired out of their setting with a report like that of a gun. This setting consisted of one part hydraulic cement to two of sharp washed sand, the brick being the best Staffordshire. The only remedy that could be applied was to reduce the pressure by pumping. This required the pumping of 18,000 galls. a minute which they have been obliged to continue to the present time.

At the Mersey Tunnel, which is also in red sandstone, they are obliged to pump from 12,000 to 14,000 galls. a minute. In the tunnel for the Croton aqueduct the leakage through the porous brick lining was estimated to be 5,000,000 galls. in the three months before opening, and the permanent and continuous leakage out of it is from one to two million gallons a month. The Metropolitan District Ry. (one of the London underground lines) has six pumping stations in constant operation.

Experiments in Sewage Treatment at Salford.

Some quite extended experiments on the treatment of sewage have been in progress during the past year at Salford, a manufacturing suburb of Manchester, England. At the present time the sewage is treated by the ordinary lime process, and the effluent is discharged into the Irwell River. With the completion of the Manchester Ship Canal, the waters of the Irwell will be absorbed for the canal, and the effluent must be of a purer quality than that produced by the lime precipitation, or it may be subject to secondary decomposition in the still reaches of the canal.

Experiments were, therefore, undertaken with four methods of sewage treatment, the International, the Electrical, the Alumino-ferric, and the Barry system, and are described by the *Manchester Guardian*. The first named system has been adopted at half a dozen places in England, and has the approval of Professor FRANKLAND. It consists in the addition to the raw sewage of a patented material known as "ferozone," about 3 grains to the gallon. This precipitates a large part of the sludge. The effluent is then filtered through a material known as "polarite," after which it is clear and colorless and does not give off any odor, although kept for weeks. The experimental plant at Salford had a capacity of about 3,000 galls. per hour and the results were highly satisfactory. The amount of sludge produced as compared with the lime precipitation process was as 1 to 2.46.

A plant of similar capacity was erected to test the Electrical system (described in ENGINEERING NEWS of Oct. 26, 1889). The crude sewage was passed through a brickwork channel 90 ft. long, in which were set 364 cast-iron plates, each weighing 200 lbs. These formed the electrodes. A 50-volt, 50-ampere current was used, and the loss of iron from the plates was found to be about 0.46 lb. per 1,000 galls. of sewage treated. The effluent was equal to that produced by the International process, and the amount of sludge was even less.

The Alumino-ferric system consists merely in the

use of sulphate of alumina with a trace of iron as the precipitant instead of lime . All the sewage of Salford was treated by this process for 48 hours, 2½ lbs. of the chemical being added to each thousand galls. of sewage. It is stated that the effluent was not very clear, and had a much higher percentage of albuminoid ammonia and organic matter than that from the first two systems. It was feared that secondary decomposition might take place if the effluent were turned into the canal.

The Barry system was tried two years ago at Salford, and discarded, but it was claimed that improvements had since been made, so further trials were made. The precipitant used is spent lime from gas works and a 6% solution of chloride of iron. The effluents had much suspended matter, and were of a brown color. They could not be distinguished by the eye from the crude sewage.

It should not be forgotten, however, that the case of Salford is somewhat peculiar; and that because the effluent in this case is required to be of exceptional purity it does not follow that the ordinary precipitation systems, using either lime or other chemicals, are not of great value and often better than the more expensive systems, wherever the requirements as to purity of the effluent are less rigid.

Bricks for Street Paving and Their Manufacture.

An article in a late number of *The Clay-Worker* describes the works and methods of the Des Moines Brick Mfg. Co. Clay is taken from a bed 50 to 60 ft. deep, and a layer of soapstone is present, and this is "mixed up with the clay and ground with it." After coming from the pit the clay is run through heavy iron rollers which pulverize it almost as fine as flour. It is then lifted to the second story, screened and deposited in a pug-mill, where water is added and the clay tempered. The tempered clay then goes to the press, where it is submitted to great pressure and the clay forced out in three continuous strings. Wires come down on these and cut the clay into bricks of the required size. The fresh bricks are then taken to a brick drying oven, several hundred feet long and 150 ft. wide in total. The temperature here ranges from 175° to nearly 200°.

The kilns, to which the dried bricks pass, hold several hundred thousand bricks, and heat is supplied by 16 furnaces, 8 on a side. There are five of the kilns in operation, with others building. The present capacity is from 70,000 to 80,000 building and paving brick per day.

According to Mr. SAM HUSTON, County Engineer, Steubenville, O., the laying of brick pavement in that city this year costs from 95 cents to $1 per square yard. In 1888 the maximum price was $1.30 per square yard.

Steubenville, O., has a large area of streets paved with brick, and its cost is said to be less there than in any other city in that state. As described by Mr. HUSTON the method of laying is briefly as follows: The street is excavated to the required depth and the surface rounded to correspond with the convexity of the pavement to be laid. It is solidified by rolling with a road-roller of not less than 7 tons, with a 4 ft. 4 in. tread. Upon the foundation thus prepared is evenly spread a layer of fine gravel 6 ins. deep. The specifications require that the foundation must be at proper grade and thoroughly rolled and rammed to the proper slope at least 100 ft. in advance of the brick laying. The latter is done in sections of not less than 100 ft.

The brick is laid on edge, at right angles to the curb, in 2 ins. of clean, sharp sand, with all joints well broken. After they have been set for 60 ft., the first 50 ft. must be lightly rammed and fine sand spread over it, sufficient only to fill the interstices, and thoroughly broomed in. After this the whole surface thus prepared is rammed with 40-lb. rammers. After one square is thus laid ½-in. of fine sand is again broomed in and the whole thoroughly rolled with the road-roller first mentioned.

Pavement laid in May, 1884, has been in constant use under heavy traffic, and up to 1889 had not cost a penny for repair. In a pavement 34 ft. wide between curbs a crown of 7½ ins. is given in laying, which rolls down to 7 ins. The surface is a segment of a circle with curbs 7 ins. above the outer edge of pavement.

New 95-lb. Rail Section Joint, and Base-Plate; Boston & Albany R. R.

The Boston & Albany R. R. has recently adopted an exceptionally heavy section of rail, which was designed by Mr. P. H. DUDLEY, and weighs 95 lbs. per yd. The rails are to be rolled at Bethlehem, Pa. The section, which is shown in Fig. 1, bears a general resemblance to the average of the suggestions for a standard type of section recommended by the Am. Soc. C. E. Committee on Standard Rail Sections, as described and illustrated in our issues of Feb. 21 and March 21, but differs in some important details. The head has slightly flaring sides and a top radius of 14 ins. instead of 12 ins. The several average dimensions of the Am. Soc. C. E. committee's individual suggestions and those used for the Boston & Albany rail are as follows:

	Am. Soc C. E. Com. averages.	B. & A. R. R.
Radius of top	12 ins.	14 ins.
" top corner of head	¼	5/16
" bottom corner of head	1/16	⅛
" top fillet	¼	⅛
" bottom fillet	¼	5/16
" corners of base	1/16	1/16
Total height	5⅛	5 1/32
Width of base	5½	5½
Width of head at top and bottom	2 23/32	2 27/32 and 3
Depth of head	1⅝	1 9/16
Height of web	2 922	2.47
Depth of flange	0.952	1.00
Thickness of web at middle	0.675	0.625
Radius of side of web	straight or 12	14
Diameter of bolt hole	.....	1
Height from base to c. of hole	.....	2 9/32

The track will be laid with broken, supported joints. The angle splice-bars are of a heavy section, with thick ribs at the bearings, and the inner bar has ribs to hold the heads of the bolts. The bars are 20 ins. long, and have four bolt-holes ⅞-in. diameter, spaced 4¾ ins., c to c. In the flange of each bar is a spike hole ⅞-in. square; the holes in the two bars of a joint are diagonally opposite, and 1 in. on each side of the center of bearing. The splice bars weigh 45 lbs. per pair. There will be four joint bolts, ¾-in. diameter, with the double Excelsior nut locks made by Ruffner & Dunn. To prevent creeping of the rails, check plates will be used, of the form shown in Fig. 2, there being one plate at the middle of each rail, opposite the joint of the other rails. This will act as a tie plate, and will be secured to the rail by one bolt, with a single Excelsior nut lock. This form of check plate is used to some extent in France. The Servis tie plate will be used, as shown in Fig. 3. The plates are 9 × 6 ins., with 3 flanges ¾-in. deep, and spike holes ¾-in. square, and will be laid on every tie except the one at the middle of each rail, where the check plate is used. About 66 miles of this track will be laid this season, and work will be commenced in May. The ballast will be of the best coarse gravel obtainable. The ties will be 8 ft. × 7 ins. × 8 ins., and will have a uniform spacing of 2 ft. c. to c. They will be of chestnut and hard or southern pine, of which latter about 100,000 will be laid this season. There will be four steel spikes 5¾ ins. long to each tie, and 15 tons of the Goldie spike (see ENGINEERING NEWS, Nov. 23, 1889) will be used as a trial.

This combination will doubtless make very good track, if only the rail is rolled properly, and does not lose in work done by the rolls what is gained in weight, which is the great difficulty to be feared with heavy sections. The purpose of the trifling flare of the head is not altogether clear. Rails weighing 80 lbs. per yd. are in use on the New York Central & Hudson River R. R., Michigan Central R. R., and New York, Lake Erie & Western R. R. (ENGINEERING NEWS, April 21, 1888; March 9, 1889, and Feb. 1, 1890). The Pennsylvania R. R. has some

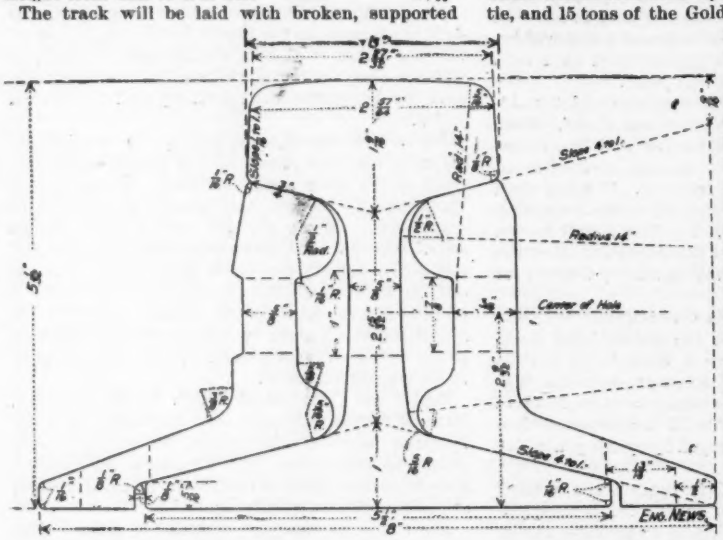


FIG. 1. NEW RAIL, 95 LBS. PER YD.; BOSTON & ALBANY R. R.

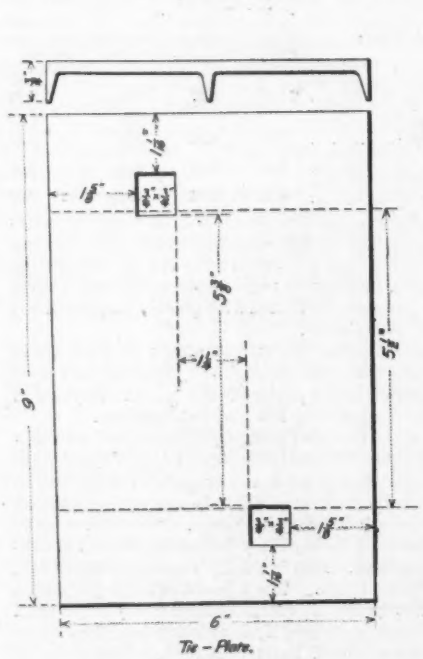


FIG. 3. TIE PLATE; BOSTON AND ALBANY R. R.

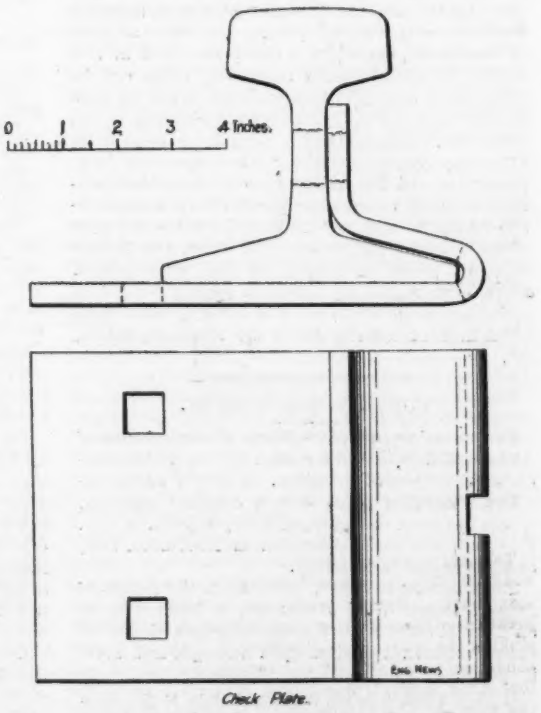


FIG. 2. CHECK PLATE; BOSTON & ALBANY R. R.

85-lb. rails (ENGINEERING NEWS, Aug. 13, 1887), and rails of the same weight are to be laid on the heavy grades of the Pacific extension of the Great Northern Ry. The Philadelphia & Reading R. R. and the Manhattan (Elevated) Ry. have some 90-lb. rails. The track in the St. Clair tunnel is laid with 100-lb. rails, and that of the Chignecto Ship Ry. with 110-lb. rails (ENGINEERING NEWS, Sept. 7, 1889). The present standard rail of the Boston & Albany R. R. weighs 72 lbs. per yd.

An Improvement in Methods of Unloading Rails.

The illustrated article under the above head, which appeared on page 307 of our issue of March 28, and which we were then unable to credit to its proper source, for reasons there stated, should be credited to Mr. C. E. LINDSAY, Engineer of Maintenance of Way of the Pittsburg, Cincinnati, Chicago & St. Louis Ry.

Wealth and Resources of Alaska.

From Census Bulletin No. 39, on the above subject, we abstract the following, which is certainly of great interest. The review was prepared by Mr Ivan Petroff, special agent for both this and the last census. It deals, in the order of their importance, with the four principal sources of wealth in this remarkable region (furs, fish, minerals and timber), and presents some almost startling figures as the result of investigations by the special agent and his assistants.

The value of the fur seal skins shipped from Alaska and sold in the London markets since the territory came into the possession of the United States is given as nearly $33,000,000, and of other furs as $16,000,000.

With regard to the fisheries of the territory, the value of the product of the salmon canneries alone from 1884 to 1890 is reported at nearly $7,000,000, and of salmon salted at $500,000. In 1890 over 3,000,000 salmon were taken at Karluk, where the largest cannery in the world is situated, and no fewer than 200,000 cases of salmon were canned at this place last year, 1,100 fishermen and packers being employed therein. The herring fishery at Killisnoo yields annually over 150,000 galls. of oil and nearly 1,000 tons of fertilizing material, and the value of the codfish catch in Alaskan waters since 1868 is stated to be fully $3,000,000.

The whale fisheries of the Arctic Ocean in 1890 yielded 226,402 lbs. of whalebone, worth from $2.50 to $3.50 per lb.; 3,980 lbs. of ivory, worth 50 cts. per lb., and 14,567 bbls. of oil, worth from 30 to 60 cts. per gall.

The total value of the precious metals exported from Alaska up to the present time approaches $4,000,000, the annual production of gold dust and bullion being now $700,000. Within a radius of 100 miles from Juneau, quartz mills have been established, with an aggregate capacity of 500 stamps. Of these, 240 stamps are employed at the well-known Treadwell or Paris mine, on Douglas Island, capable of reducing 600 tons of ore per diem when both steam and water power are utilized. There are said to be extensive deposits of copper in the territory, but the difficulty of transportation has hitherto prevented its development. Lignite coal of superior quality is also found in various places, but is mined at only one point.

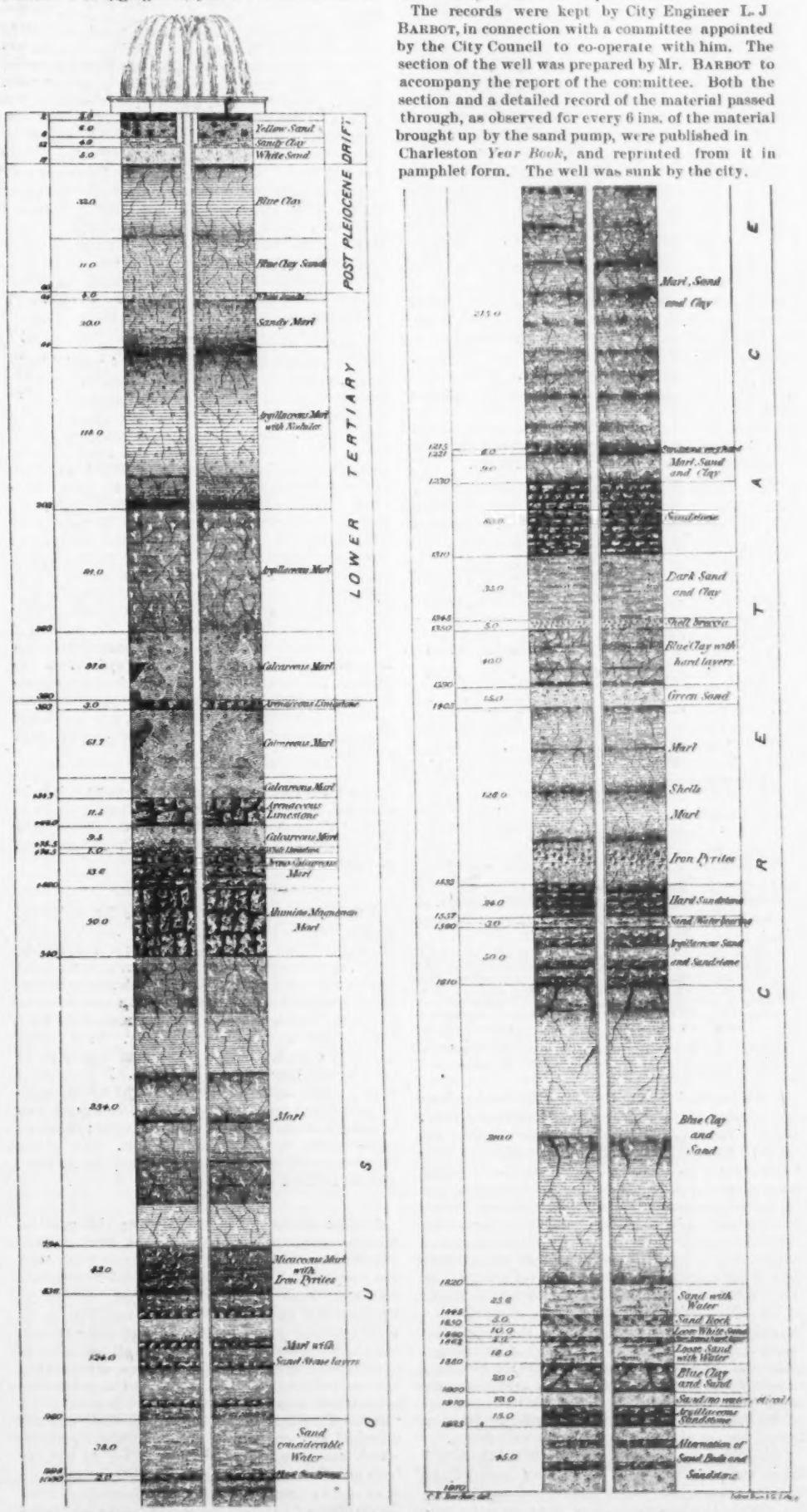
Mr. Petroff states that he is very confident that the amount of merchantable timber has been greatly overestimated. Especially is this true of the yellow cedar, an exceedingly valuable tree, which is to be found only in isolated groves. Nine sawmills are already in operation. The exportation of timber products is prohibited by law, and even their local utilization is much restricted.

The Marion Square Artesian Well, Charleston, S. C.

The accompanying illustration shows a deep well at Charleston, S. C., which, though sunk some years ago, is yet of interest, owing to its depth and the great care taken in recording the strata pierced in sinking the well. It will be noticed that the clays, sands and marls extend to a considerable depth before stone is reached, and that they alternate with the stone to the full depth of the well. The first marl is struck at 64 ft., and is a sandy marl layer 20 ft. deep. Argillaceous marl, first with, then without, nodules, and then calcareous marl follow.

The first stone, as shown on the section, is at 390 ft. below the surface, and is but 3 ft. thick. At 454.7 ft. another layer of stone was found, this time 11.5 ft. thick. The aggregate depth of the various stone strata is slight compared with the depth of the well, yet is divided up among no less than 19 different layers, separated by earthy material. Beginning at 1,610 ft. blue clay and sand were found for 210 ft., or to a depth of 1,820 ft. At 1,970 ft. a sandstone was struck, which was not penetrated.

The records were kept by City Engineer L. J BARBOT, in connection with a committee appointed by the City Council to co-operate with him. The section of the well was prepared by Mr. BARBOT to accompany the report of the committee. Both the section and a detailed record of the material passed through, as observed for every 6 ins. of the material brought up by the sand pump, were published in Charleston *Year Book*, and reprinted from it in pamphlet form. The well was sunk by the city.



DEEP ARTESIAN WELL AT CHARLESTON, S. C. L. J. BARBOT, CITY ENGINEER.

THE ZONE TARIFF IN SWEDEN has proved unusually successful, according to recently received statistics for June to November, 1890. The passengers carried and earnings, as compared with those of the same months in the preceding year, were as follows:

	1889.	1890.	Per cent increase
Passengers, 2d class	8,311	11,158	34.3
" 3d "	56,665	80,057	41.4
Earnings, 2d class, approx	$3,970	$4,450	12.2
" 3d " "	11,280	11,340	0.5

THE BUILDING PLANS FOR THE WORLD'S FAIR were formally adopted on Feb. 27 by the National Commission's Board of Control. The plans provide for an area of 102.7 acres as follows: Fisheries buildings, 1.7 acres; fisheries annex, 5; government building, 3.6; manufactures, 31.2; electrical, 5.6; mines, 5.6; agricultural, 9.2; machinery, 9.7; machinery annex, 8.7; annex for power, 8.3; horticultural, 5.7; women's building, 2.3; administration, 1.4 acres.

A NOVEL METHOD OF STRENGTHENING IRON CASTINGS has been brought out by Mr. A. JEPSON, of Manchester, England. The process consists simply in casting the metal around a wrought-iron core. Thus, for thin plates, like stove plates, a thin wrought-iron perforated plate is placed in the center of the mold, and the metal is poured around it. Wire (either straight or in coils), rods, bars, sheets or any form of iron, may be used according to the shape of the casting. It is stated that the close union of the cast iron with the wrought is assured by plating the wrought core with a thin coat of tin.

THE MAIN FACTS AS TO THE GRAPE-GROWING INDUSTRY, as shown in much detail in Census Bulletin No. 38, may be summarized as follows. Unfortunately, there are no corresponding figures for 1880 with which comparison can be made:

	Cal.	Ohio.	N. Y.	Other.	Total.
Acres in bearing vines	155,272	28,087	43,350	80,866	307,575
Acres in non-bearing vines	45,272	4,956	7,650	35,808	93,686
Av. tons grapes per acre	1.77	1 80	1.75	.....	.....
Av. value per ton	$17.06	$37.00	$70.00	.....	.....
Tons used for table	38,785	38,947	60,687	128,852	267,271
Tons used for wine	171,108	11,609	15,172	42,561	240,450
Tons used for raisins	64,108	.....	.....	.....	64,418
Wine made, M. galls.	14,626	1,935	2.528	5,218	24,307
Value, per gall	19 cts.	56 cts.	50 cts.	.....	.....
Total value, land and plant, millions of dollars	86.64	13 22	20.40	35.40	155.66
Total laborers employed	100,422	16,521	25,500	58,337	200,780

It will be seen that in round numbers California and the rest of the Union divide the grape industry equally between them. In 1870 only 3,000,000 galls. of domestic wines were produced. The report further states:

As California has the largest vineyard in the world (3,800 acres) it may be well to state that she has also the smallest. It is a vineyard consisting of a single vine, in Santa Barbara Co. It was planted by a Mexican woman about 68 years ago, and has a diameter 1 ft. from the ground of 12 ins., its branches covering an area of 12,000 ft., and produces annually from 10,000 to 12,000 lbs. of grapes of the Mission variety (many bunches weighing 6 and 7 lbs.), the crop being generally made into wine. The old lady who planted this one-vine vineyard died in 1865 at the age of 107.

THE FOURTH AVENUE TUNNEL DISASTER has been investigated by the New York Railroad Commission, and as a result the following recommendations are made: The audible signal at the entrance to each block should be improved to insure its sounding when standing at danger and passed by a train, and torpedoes may be used in addition; additional measures should be adopted for constant inspection of the signal lights and wires, and an electric device should be provided to show the operator in the cab the position of the signals; every engine-driver and fireman running through the tunnel should have a certificate of perfect eyesight and color perception; no train should be permitted to run through the tunnel faster than 15 miles per hour, this speed to be reduced under unfavorable conditions to a rate slow enough to insure the engineer and fireman seeing the signals, this reduced speed to be the rule until improved methods shall demonstrate to the Board that the tunnel may be used at higher speeds with safety.

Concerning the ventilation of the tunnel the Board favors the construction of ventilating towers from the side tunnels, but desires the railway company to investigate the best methods of improving the ventilation and report the results, with a view to securing permissive legislation. The Board believes that lighting the tunnel would make the signal lights less visible. The question is to be tested, however, by stringing incandescent lights in the side tunnel opposite the signals. The Board is satisfied that the present system of signals is not sufficient to secure safety.

Reports received since the above was in type state that the order limiting the speed to 15 miles per hour has been withdrawn by the Board so far as the running of trains in favorable weather is concerned. It is required, however, that when trains are run at greater speed a man shall be stationed at each home signal, with instructions to place torpedoes on the track whenever the signal is at danger, and to go back on the track and warn following trains whenever a train is stalled near the home signal. It is also required that duplicate signals shall be erected on each side of the track, so that both engineer and firemen can see the signals. The Board does not seem to be aware of the fact that an automatic torpedo machine would place torpedoes on the track as well as a man, and would never strike or desert its post.

TRUCK FARMING, or the culture of vegetables in localities remote from markets, where products have to be shipped by water or rail to the points of consumption, has become an important industry in this country. Its growth is of course almost wholly due to the provision of cheap and rapid railway transportation, by which these perishable products can be delivered to distant markets in good condition. According to a recent census bulletin, the capital invested in this industry is now over $100,000,000, and the total value of the products in the census year was $76,517,155 after paying freight and commission. This product was raised on 534,440 acres of land, which shows an average gross return per acre of $143.17. It is not generally realized how important are such industries as this, compared even with such industries as the manufacture of iron, news concerning which is always before the public. The total production of pig iron in the census year was 9,579,779 tons, whose total value at $16 per ton was $153,276,464, or just about double what was produced by the little known industry of truck farming.

THE NEW YORK STEAM CAR HEATING LAW is to be enforced, no matter who it hits. The Grand Jury at New York has indicted the directors of the New York, New Haven & Hartford R. R. for a misdemeanor in violating the law.

A FUNERAL CAR has been added to the equipment of the Western Railway of France. It is about 20.5 ft. long over the body and 23.6 ft. over the buffers; 8.3 ft. wide inside. It is carried on 2 rigid axles with a wheel base of 12.3 ft. The interior is divided into 3 compartments. At one end is a compartment 6.56 ft. long with a frame for the reception of the coffin, which is placed across the car. At the other end is a compartment of the same length to be used for the conductor of the train. It is provided with a raised hood in the roof. The middle compartment has accommodation for 7 first-class passengers, 4 on one side and 3 on the other; the seats can be made up into beds at night. Part of the compartment is occupied by a lavatory 2.5 ft. wide. The car is fitted with air brakes.

A FINE COLORED SHEET, showing the greatest modern engineering achievements, such as the Washington Monument, BARTHOLDI'S "Liberty," the Forth and Brooklyn bridges, Eiffel Tower, etc., has been issued by Messrs. Merchant & Co., of Philadelphia, and deserves special mention for its highly artistic character, like some of their preceding advertisements. The sheet has all the effect of a water-color drawing, and will be an ornament to the walls of any office. Another quaint advertisement which is so novel as to deserve mention is an "Easter Offering" of a broken egg shell daintily mounted and containing a yellow (paper) yolk, on which are inscribed some facts, which we are far from questioning, as to the parallel between the use of an egg by Columbus and by the Mason Regulator Co., to illustrate certain important truths which the world needs to know.

AN EADS MONUMENT ASSOCIATION has been formed to carry out the project which we have previously noted, of a monument to the late JAMES B. EADS. Mr. E. L. CORTHELL, of Chicago (205 La Salle St.), is President, and Mr. E. D. MEIER, of St. Louis (102 North Main St.), Secretary of the association, which now invites large or small contributions from engineers and others desiring to contribute toward a fitting memorial of a great engineering career. The monuments to engineers are not many as yet in this country, and all engineers should feel an interest in seeing this one erected. Contributions may be sent to either of the gentlemen named above.

THE 10,000 HP. DYNAMO for the Deptford station in London is still far from complete, it being too large a machine to admit of hurried work. Some idea of its size can be obtained from the fact that the armature will be 40 ft. in diameter, with a shaft 36 ins. in diameter. It will be driven at a speed of 60 revolutions a minute by 2 compound vertical condensing engines of 5,000 HP. each, one on each side of the armature. Two smaller machines of the same type are now running. These have armatures 12½ ft. in diameter and are rated at 1,500 HP. Each is driven by a compound vertical condensing engine of the marine type by 40 five inch ropes.

THE LEADING GERMAN CITIES have grown quite rapidly in the last five years, as is shown in the following table including all cities of over 200,000 inhabitants, prepared from figures given in *Engineering*:

City.	1885.	1890.	Per cent. inc.
Berlin	1,315,000	1,574,500	19.7
Hamburg	471,000	570,500	21.2
Leipsic	193,709	353,300	82.3
Munich	261,900	344,900	31.7
Cologne	239,500	282,500	18.0
Dresden	246,000	276,000	12.2
Magdeburg	160,100	200,100	25.0

This is faster even than the average of corresponding American cities, and is one of the most notable phenomena of modern times.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Rockaway Valley.—Construction is being rapidly pushed on the extension toward Morristown and it is expected to have the 6 mile section from Peapack to Mendham, completed by June 1. The road will ultimately be extended to Morristown, N. J., about 8 miles further.

Philadelphia & Seashore.—The injunction against this company asked by the contractor, Elward R. Wood, has been denied, and it is reported that work will begin soon on the extension to Sea Isle City, N. J. The line from Winston Junction to Tuckahoe, N. J., was built last season.

Concord & Montreal.—At a recent meeting of the directors of this company it was decided to commence work at once on the line from North Weare to Henniker, N. H., about 6 miles. It is hoped to have the line in operation by June 1.

Cleveland, Wooster & Western.—Arrangements are reported completed by which the Akron & Chicago Junction R. R. will build a branch from Lodi or Burbank to Wooster, O., 20 miles. Ryan & McDonald, of Baltimore, Md., have the contract, and will, it is stated, have the line completed by Oct. 1.

Findlay, Fort Wayne & Western.—Dispatches state that work has been resumed on the partly graded extension from Glendorf, Ohio, to Fort Wayne, Ind., 55 miles.

Brooklyn & Rockaway Beach.—This company will issue $350,000 of bonds, the proceeds to be used in making improvements. Among the most important of these will be the construction of two new steamboats to run to the fishing banks, the double tracking of the road and the enlargement of the terminal facilities at East New York and Canarsie. There is also talk of an extension.

Philadelphia & Reading.—The contract has been let for constructing the Port Reading R. R., projected to run from Bound Brook to New York Harbor, 19 miles. Work is to be completed within one year.

Valley (O.).—It is reported that this company will build a railway from Valley junction to Canal Dover, Ohio.

Delaware & Eastern.—This company has been organized in Ohio to build a railway over the old partly graded roadbed of the Cleveland, Akron & Columbus R. R., from Delaware to Centerburg, O. D. Paul, of Centerburg, O., and E. H. Hyatt, of Delaware, O., are interested.

Pennsylvania.—There is a rumor that the Northern Central R. R. will build a line from Canandaigua to Niagara Falls, N. Y.—Surveys are in progress for a line from Sea Isle City to Avalon, N. J., 4 miles. It is expected that the line will be built at once.

Louisville, Madison & Cincinnati.—This is the name of the company which was noted last week as preparing to build a railway north and south through Ripley Co. The line is projected in the interest of the Cleveland, Cincinnati Chicago & St. Louis R. R., and will run from Aurora, Ind., to Louisville, Ky., about 100 miles. J. C. Fawcett, of Louisville, Ky., is interested.

Portland & Rumford Falls.—It is reported that this company will build an extension over the route of the old Sebago Lake & Mechanic Falls R. R., connecting with the Maine Central R. R. at Windham, Me.

Quebec Central.—A meeting of the stockholders will be held May 5 to vote on constructing the extension from Tring Station to Lake Megantic, P. Q. The surveys have already been made.

Chicago, Kalamazoo & Saginaw.—A press dispatch states that this road will be extended from Kalamazoo south to Marcellus, Mich, and from Woodbury north to St. Johns, Mich.

Wilkesbarre & Western.—Surveys are in progress for the proposed extension from Wilkesbarre, Pa., to White Haven, Pa. It is expected that construction will commence this season. Work is also reported in progress on the line from Williamsport, Pa., to a connection with this road.

Projects and Surveys.

Dayton, Lebanon & Cincinnati.—A press dispatch from Dayton, Ohio, says:

The Dayton, Lebanon & Cincinnati R. R. Co. has been incorporated to parallel the Cincinnati, Hamilton & Dayton R. R. from this city to Cincinnati, a distance of 60 miles. Only about 20 miles of the road are to be built. A link 6 miles southeast of here will be commenced soon to connect the Dayton, Fort Wayne & Chicago with the Lebanon & Northern, thence over the Henry Lewis road to Dudds Station, thence over 12 miles of road to be built to the Middleton & Cincinnati R. R., which is owned by the Cincinnati, Columbus, Cleveland & St. Louis R. R., to the Little Miami R. R. at King's.

Brookline.—This company, recently chartered in New Hampshire, proposes to build a railway from a point on Lake Polanopo in Brookline, N. H., to a point on the Massachusetts State line.

Eastern Central.—This is the name of the latest company which proposes to parallel the Pittsburg, Fort Wayne & Chicago R. R. According to press dispatches the route will be from Bowerstown, Harrison Co., O., via Fort Wayne, Ind., to Chicago, with a branch from Galion or Bucyrus, O., to St. Louis, Mo.

Detroit & Mount Clemens.—It is proposed to build a railway by this name from Detroit to Mount Clemens, Mich. Wm. B. Moran, of St. Clair, Mich., is interested.

Little River.—The projectors of this recently chartered company will hold a meeting at Woodsville, N. H., May 11, for organization.

Barberton Belt.—Chartered in Ohio to build a belt line railway at Barberton, O.

Toronto, Sudbury & Pacific.—This company has applied to the Dominion Parliament for a charter to build a railway from Toronto to Sudbury, Ont.

Waldo.—Chartered in Maine to build a railway from Stocton Springs to Camden, Me.

Seneca County.—John H. Gould, of Seneca Falls, N. Y., President, writes us that the surveys have been completed for this road, which is to run from Seneca Falls, N. Y., via Waterloo, to Geneva, N. Y., a distance of about 10 miles. A very favorable route has been secured. The object of the road is to connect the large manufacturing villages of Seneca Falls and Waterloo with the Lehigh Valley R. R. at Geneva.

Syracuse & Deposit.—A project is on foot to build a railway from Syracuse, N. Y., southeast to Deposit, N. Y. The route is through a fine farming section of the state.

SOUTHERN.—Existing Roads.

Chattanooga Union.—This road has been purchased by a syndicate of Boston, Mass., capitalists, which proposes to make larger additions to its equipment and extend the line in connection with the Lookout Mountain R. R. to the coal fields on Lookout Mountain.

Louisville & Nashville.—The line from Cumberland Gap, Tenn., to Big Stone Gap, Va., has been completed, and will be put in operation at an early date. The total length of the road is 71 miles, of which distance about 30 miles were completed in 1890.——It is reported that a branch from Hartselle, Ala., west into Lawrence Co., 20 miles, is contemplated.

Nashville, Chattanooga & St. Louis.—Surveys are in progress for the extension of the Tennessee & Coosa R. R. north from Guntersville, Ala., to a connection with the main line.

Wantauga Valley.—It is stated that this road, now under construction from Carter's Station to Wantauga, Tenn., 5 miles, will be extended from the latter point to the mines east of Caranberry, N. C., a distance of about 35 miles.

Charleston, Sumter & Northern.—Work has been considerably delayed on the extension from Sumter and Bennettsville, S. C., by the wet weather, but it is hoped to have the line in operation early in the summer. The road is now completed from Sumter north 35 miles, and from Bennettsville south 6 miles. On the remainder of the line the grading has been completed, and the trestles and bridges built ready for tracklaying. The total length of the line is about 62 miles.

Richmond & Danville.—Tracklaying on the Winston & Mocksville branch is proceeding at the rate of ¾ mile per day.

St. Cloud Sugar Belt.—It is stated that the extension from Narcoose to Orlando, Fla., has been surveyed, and that the right of way, with the exception of about 2 miles, has been secured. Work will begin at once.

Georgia, Carolina & Northern.—Tracklaying on the division west of the Savannah River is progressing at the rate of one mile per day. The grading and bridge-work is all completed between Elberton and Athens, Ga., and it is hoped to have the track laid by May 1.

West Virginia Central & Pittsburg.—A press dispatch says:

President Davis, of the West Virginia Central, says that arrangements are about completed for the extensions of his road to Pittsburg, thus affording a direct line from Lynchburg, Va., to Pittsburg. The extensions will tap four great systems of railroads. The West Virginia Central will then have as feeders the Norfolk & Western at Lynchburg and the Chesapeake & Ohio at Covington, in the South; the Baltimore & Ohio and Pennsylvania in the North. The extensions include three probable directions in West Virginia. One is southward to connect with the Chesapeake & Ohio and Norfolk & Western; one westward, passing through Buckhannon and coming out on the Ohio River; and a third is to carry the line northward from Elkins to the Grafton & Green Brier road, which is to be converted into a standard gage, and thence to Pittsburg by the Morgantown branch of the Baltimore & Ohio. Negotiations are now pending between the West Virginia Central and Baltimore & Ohio to effect this arrangement. Negotiations are also pending to the same end with the Pennsylvania to reach Pittsburg over that line from Bealington, to which point the West Virginia Central is now building a line from Elkins.

Atlantic Coast Line.—This company is now securing the right of way for its proposed branch from Greenville to Washington, N. C., 20 miles. As soon as the right of way is secured construction will begin.

Blackville, Alston and Newberry.—This company has submitted a proposition to the Board of Trade, Greenwood, S. C., relative to the extension of its road from Seivern to that place.

Projects and Surveys.

Cartersville and Gainesville.—Parker N. Black, of Atlanta, Ga., Civil Engineer, writes us that the preliminary survey for this Alabama railway will begin about April 15. The road is to run from the East and West R. R. of Alabama at Cartersville, Ala., to Gainesville, Ala., 73 miles. An abstract from the engineer's report was given in our issue of March 14.

Montgomery & Sylacauga.—This company, which was chartered some years ago, has been reorganized under the name of the Alabama Grand Trunk R. R. Co. The road is projected to run from Montgomery to Sylacanga, 60 miles, and the surveys have been completed.

Pittsburg, Washington & Southern.—This company was chartered in West Virginia last Thursday. It proposes to build a line from Blacksville, Monongalia Co., by way of Manington, Marion Co., to Clarksburg, Harrison Co. The principal office will be at Manington, and the incorporators are T. M. Jackson, C. W. Cowan, J. H. Furbee, and A. N. Pritchard.

Dun Glen.—Chartered in West Virginia to build a railway from the mouth of Lower Long Creek at Deep Water by way of Long Creek, Arbuckle Creek, Dunn Loup Creek and Pony Creek, to a point on the Bluestone Road in Mercer Co. The capital subscribed is $200,000, and is held by J. F. Brown, M. Jackson, C. B. Couch, and Joseph Ruffner, all of Charleston.

Greenbrier & Gauley River.—Chartered in West Virginia for the purpose of building a line from a point in Monroe Co., near Alderson, by way of Meadow River, Muddy Creek, Big Clear Creek, Laurel Creek and Cherry River to a point on Gauley River, in Nicholas Co. The office of the company will be at Alderson. The incorporators are Alex. McVeigh Miller, Enoch Smith, William Proctor Smith, T. H. Jarrett and Henry Gilmer.

Georgia, Tennessee & Illinois.—This company has been chartered in Alabama. The road, as stated some time ago, is to run from Tuscaloosa, Ga., to Chattanooga, Tenn.

Atlantic & Northwestern.—This company, recently chartered in Georgia, proposes to build a railway from Augusta, Ga., to Chattanooga, Tenn. It will follow nearly the same route as the Augusta & Chattanooga R. R. survey. The Piedmont Construction Co. has been organized to build the road. R. M. Mitchell, President, Augusta, Ga.

Jackson & Garysburg.—An effort is being made by the people along the route to secure the construction of a railway from Jackson to Garysburg, N. C., 12 miles.

Alabama.—At the last session of the Alabama State Legislature, $9,000 was voted for the survey of a railway to connect the Tennessee River with the Gulf of Mexico. The commission appointed to locate the route has decided to survey a line from Florence to Mobile. John A. Milner will be the engineer in charge.

New River & Kanawha.—A meeting of the stockholders will be held at Fayetteville, W. Va., April 17, to complete the organization of this company. J. H Gaines, Fayetteville, W. Va., is interested.

Mobile Transportation Co.—R. K. Warren, of Mobile, Ala., writes us as follows:

This road is projected to run from Mobile, Ala., via South End, Bell Fountaine, Parkers and Alabama Port, to Portersville, Ala., a distance of 26 miles, including a belt line around city of Mobile. The preliminary surveys are now in progress. It is proposed to build a first-class roadbed, laid with 60-lb. steel rails; maximum grade, 0.5%. The route is through a fine agricultural section. The object of the road is to develop the business of the port of Mobile, by connecting the city with deep water by its line and by building a pier and facilities for unloading vessels at Alabama Port. The pier will be about five miles long. Nearly all of the right of way has been secured and considerable other local aid obtained. It is thought that favorable traffic arrangements can be made with the Mobile & Ohio, the Louisville & Nashville, and the East Tennessee, Virginia & Georgia railways. It is expected that the line will be ready for the local freight and passenger business this season and that the pier will be completed ready for export business by the fall of 1892. The estimated cost of the line is about $1,025,000.

NORTHWEST.—Existing Roads.

Ohio & Mississippi.—A correspondent sends the following:

The location of a line from Cypress Junction, about 6 miles north of Shawneetown, Ill., to a point opposite Paducah, Ky., has been completed. The length of the line will be about 54 miles. The object of the survey was to secure definite information of the cost and feasibility of such a line. There is no immediate prospect of construction.

Minneapolis, St. Paul & Sault Ste. Marie.—An official of this company informs us that the contracts have been let for building 80 miles of the extension from Hankinson to Valley City, N. Dak. About 40 miles are now graded.

Wisconsin Central.—It is reported that this company will commence work on the Chicago, Lake Geneva & Pacific R. R. at an early date. The road is projected to run from Lake Geneva to Jefferson, Wis., about 40 miles, and this action toward construction is being taken to prevent the forfeiture of subsidies voted the enterprise some time ago.

Northern Pacific.—It is stated that surveys have been made for a line from Wallahalla, N. Dak., to Morden, Man., and thence to Portage la Prairie, Man.

Chicago, Rock Island & Pacific.—An ordinance will soon be introduced in the Chicago City Council permitting the Chicago, Rock Island & Pacific R. R. Co. to build a 6 track elevated road over its present right of way from its city depot to Englewood, to be used for the passenger service of that road and the Lake Shore & Michigan Southern.

Chicago, Milwaukee & St. Paul.—It is stated that this company is considering the construction of a line from Mankato to Northfield, Ia.——There is talk of a branch being built from Berlin to Knowlton, Wis.

Projects and Surveys.

Joliet, Lisbon & Western.—Chartered in Illinois to build a line of railway from Joliet, Ill., west via Lisbon, Ill., about 100 miles.

Rapid City, Missouri River & St. Paul.—A company by this name has been organized at Rapid City, S Dak., for the purpose of building a railroad from that place through the Black Hills mineral region. Among the incorporators are: R. C. Lake, H. S. Hall and F. R. Davis, all of Rapid City, S. Dak.

SOUTHWEST.—Existing Roads.

Missouri Pacific.—It is stated that surveys will begin at once for the proposed line from Bagnell to Carthage, Mo.

Mississippi River & Bonne Terre.—Surveys have been completed for an extension from Bonne Terre to Doe Run, Mo., about 15 miles.

Projects and Surveys.

Texas.—A press dispatch says that the city of Victoria, Tex., has subscribed $75,000 in aid of the proposed railway to deep water. A charter will be applied for at once and surveys made for the line.

Clarendon, Oklahoma & St. Louis.—This company has completed its organization by the election of J. W. Carhart, president; J. D. Stocking, vice-president, and W. L. Sage, secretary.

Dublin & Lampasas.—The project of building a railway from Dublin to Lampasas, Tex., is being agitated by the people along the route.

ROCKY MT. AND PACIFIC.—Existing Roads.

Chino Valley.—An effort is being made to secure the extension of this railway from Harrington, Cal., to the coast.

Rio Grande Western.—A circular has been issued by the Rio Grande Western Ry. Co. to its common and preferred stockholders announcing that, in view of the steadily increasing business of the road, the directors have declared a dividend of 1½% in cash for the quarter ending March 31, payable May 1. New equipment to the extent of $450,000 is needed to prepare for the prospective further increase of business this year. The general manager has recommended the construction of a new line over the Soldier Summit Pass, which shall reduce the only excessive grade on the line from 200 ft. per mile to about 106 ft., at an expense of about $300,000. He has also recommended an enlargement of the shops at Salt Lake City and other increased facilities and improvements to the extent of $50,000. The directors have decided to carry out these improvements.

Southern Pacific.—The grading has been completed, and tracklaying will soon begin on the line from Coburg to Springfield, Ore.

Canadian Pacific.—About 70 miles of the Sutsap & Okanogan Ry. have been completed, and construction is now in progress along the west shore of Okanogan Lake. The road leaves the Canadian Pacific main line at Kam-

loops, B. C., and will run to a point on the International line near Osogoos Lake.

Projects and Surveys.

Nicola, Kamloops, Similkameen Coal & Ry. Co.—A charter has been asked from the British Columbia Legislature for a railway from Spence's Bridge to Osogoos Lake, 130 miles.

Silver City Northern.—Chartered in New Mexico to build a railway from Whitewater, N. Mex., on the Atchison, Topeka & Santa Fe R. R., north to Georgetown, Grant Co., a distance of 19 miles. Among the incorporators are Lawrence Perkins, New York City; Henry F. Grierson, Las Vegas, N. Mex., and G. G. Posey, Silver City, N. Mex. The principal offices will be at Silver City.

Port Angeles & Southern.—Chartered in Washington to build a railway from Port Angeles, Wash., to Port Discovery Bay and Port Townsend, Wash. Among the incorporators are: C. E. Mallette, of Port Angeles, Wash., and N. N. Singleton, of Seattle, Wash.

Seattle, Boise & Salt Lake.—Surveys are now in progress for this proposed railway from Salt Lake City to Puget Sound. J. W. Bates, Payatte, Idaho, General Manager.

Colorado.—A railway company has been chartered to build a line from Delta, Col., up the North Fork of the Gunnison River to tap coal fields in that vicinity.

Manitoba, Assiniboine & Grand Junction.—An application will be made to the Canadian Government for a charter to build a railway by this name from a point on the Qu Appelle, Long Lake & Saskatchewan Ry. to a point on Hudson Bay.

FOREIGN.

Jamaica, West Indies.—The Jamaica Railway Co., of London, England, will issue $1,600,000 first mortgage 4 per cent. bonds. The existing lines, from Kingston to Spanish Town and Porus, and from Spanish Town to Ewarton (about 65 miles in length), were owned and worked by the government of Jamaica before their transfer to the Jamaica Railway Co. on Jan. 1, 1890. The company was then authorized to acquire two extensions now in course of construction from Porus to Montego Bay, and from the Ewarton line to Port Antonio, being respectively about 65 and 55 miles in length. One section of 12½ miles from Porus was opened for traffic Jan. 22, 1891. Further issues of bonds can only be made as 25 miles of extensions are completed and approved by the government.

Mexican, Cuernavaca & Pacific.—Chartered in Colorado to build a railway from the city of Mexico to Cuernavaca and the east, a distance of 220 miles. The officers are George Fritch, President; General Strum, Vice-President and General Manager; Charles Wheeler, Secretary; A. B. Heath, Treasurer, and Major John T. Butman, of Saratoga, N. Y., Superintendent of Construction. General Strum has a concession from the Mexican government which gives him the right of way and exempts the company from taxation for 30 years. Work on the road will be begun as soon as General Strum can reach the city of Mexico.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are reported as probable in the following places: Amsterdam, N. Y., address the Amsterdam & Rockton St. Ry.; Findlay, O., address the Findlay & Wyoming Place St. Ry.; Seymour, Ind., address A. M. Beatty; Omaha, Neb., address the Metropolitan St. Ry. Co.; North Adams, Mass., address E. J. Slattery, Albany, N. Y.; Waukegan, Ill., address the Waukegan City Ry.; Bridgeport, Conn., address the East End Ry.; Springfield, Mass.; South Austin, Tex.; Savannah, Ga., address the Savannah Electric Ry.; Long Island City, N. Y., address the Long Island City & Newtown R. R.; Gloucester, Mass., address the Gloucester St. Ry.; Salem, Ore., address the Capital City Ry.; Portland, Ore., address the Metropolitan Ry.; Selma, Ala., address the Selma St. Ry.; Graham, Va., address W. Graham; Auburn, Me.

Lawrence, Mass.—The Railroad Commissioners have granted permission to the Merrimac Valley St. Ry. Co. to increase the capital stock from $83,000 to $250,000 to purchase an electric equipment.

Providence, R. I.—The Railroad Committee of the City Council has reported in favor of allowing the Union R. R. line to Pawtuxet to be operated by electricity.

Brooklyn, N. Y.—The Brooklyn City Ry. Co. has decided to issue $6,000,000 bonds for the purpose of extending its lines to Gravesend and equipping the entire system with electricity.

Baltimore, Md.—The North Ave. Ry. Co. has received permission to extend its lines 1½ miles, about 4,000 ft. being carried on a double track elevated structure. L. W. Serrell, of New York, will be Chief Engineer. The legal questions involved in granting the permission are explained as follows by F. H. Smith, the resident engineer:

The State law prohibits the building of elevated railroads except under special charter, but another State law of later date enables railroads generally to abolish or avoid grade crossings by tunneling or bridging other roads. Our North Ave. Co. wanted to come down North St., which is already occupied by the tracks of the Northern Central R. R. Co. running longitudinally, and with 26 spur tracks running into depots, warehouses, etc., and diverging from the main tracks herring-bone fashion. I have located the overhead tracks so that they cross these spur tracks near the curb lines of the street, and as these spur tracks are too close together to allow us to descend and ascend between the crossings we thus get a set of bridges abutting together instead of 26 separate bridges.

Vincennes, Ind.—It is reported that the Citizens' St. Ry. will be double tracked and operated by electricity shortly. The matter is now before the City Council, which is said to favor the changes.

Menominee, Mich.—Over $65,000 is said to have been subscribed for the construction of a road in this city.

San Francisco, Cal.—The South San Francisco Land & Improvement Co. will soon let contracts for grading the roadbed of the electric line it will build from San Bruno Point to Baden.

Portland, Ore.—Surveyors are now engaged in locating the line of the electric railway from this place to Oregon City, 15 miles distant.

Dummy Railways.—New lines or extensions are reported as probable in the following places: Asheville, N. C., address J. A. Reagan, of Weaverville; Onset, Mass., address the Onset St. R. R.; Lutherville, Ga.; Gaffney City, S. C.

Alameda, Cal.—E. M. Greene, R. M. Fitzgerald and others have applied to the supervisors for a franchise for a line on several streets, the power to be furnished by the Hoskins motor.

Cable Railways.—*Brooklyn, N. Y.*—Christie & Lowe, 45 Broadway, New York, have begun work on the Montague St. Ry., for which they are the contractors.

New York, N. Y.—Work has begun on both the Broadway and Third Ave. cable roads.

Dallas, Tex.—A. W. Childress will build a 6½ mile line in this city.

Horse Railways.—New lines or extensions are reported as probable in the following places: New Albany, Ind., address the Highland Ry.; Chillicothe, O., address the Chillicothe St. Ry.; Savannah, Ga., address the Savannah & Isle of Hope Ry.; Greensboro, N. C., address the Greensboro St. R. R.; Martinsburg, Va., address S. W. Walker; Danville, Va., address J. A. Herndon.

Charlottesville, Va.—W. S. Ficklin will build a line in this place. One of the existing lines is reported as about to introduce electricity.

Columbus, Ind.—The Columbus St. R. R. Co. is being organized to build a 4-mile line here.

Elevated Railway.—*Philadelphia, Pa.*—The Northeastern Elevated R. R. Co. was reorganized March 26 with F. B. Esler as President. Among the directors are Edward Lauterbach, Vice-President of the Brooklyn Elevated R. R., and Colonel F. K. Hain, General Manager of the Manhattan Elevated R. R. The proposed road will be 12 miles long, and is estimated to cost $350,000 to $400,000 a mile.

New Companies.—Westchester Electric R. R. Co., Mt. Vernon, N. Y., capital stock, $30,000; Directors: J. A. Bower H. N. Curtis, H. C. Radford and others, all of New York.

Waverly-Woodstock Electric Ry. Co., Portland, Ore.; incorporators: J. W. Campbell, F. C. Surger, W. G. De Celle. Keyport & Matawan St. R. R., Keyport, N. J., $50,000; T. S. R. Brown, J. W. Keough, A. W. Brown, E. Sprout.

HIGHWAYS.

New York.—A Buffalo paper has the following:

Dun & Co.'s weekly Review of Trade reports depression which it attributes in a large degree to "the bad condition of the country roads." There were arguments enough before to prove the wisdom of Gov. Hill's recommendations for the improvement of the public highways, but this in addition is in itself conclusive. Upon the mere material consideration of trade—free trade—alone, it would be economy for the state to mend its ways and keep them in the best possible condition.

Maryland.—A petition for a new county road 30 ft. wide has been presented to the Commissioners of Baltimore Co.

Tennessee.—Senator Curtis' road bill has been passed by the Senate. A commissioner is provided for in each road district, and in addition to labor a tax of 5 cts. on the $100 is levied; also a privilege tax not to exceed one-fourth of the state privilege tax.

Texas.—The new road bill has been passed. Several counties are exempt from its operations.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Kingston, Ont.*—A bill has been introduced in the New York Legislature incorporating the Wolfe Island Bridge Co. for a bridge from Cape Vincent to a point at or near Kingston, Ont. The capital stock is $500,000. Thomas Brown, C. B. Hancock, Joseph M. Holmes, Henry B. Archer and H. D. Kirkhover are named as commissioners to locate the bridge.

Waterford, Vt.—The Pittsburg Bridge Co. has the contract for the highway bridge at this place. The structure will cost $9,000.

Elizabethton, Tenn.—A bill has been introduced in the legislature authorizing the construction of a bridge over the Watauga River.

Duluth, Minn.—The plans of the railway company for a viaduct across the railway track at Lake Ave. have been adopted by a joint committee of property owners and the City Council.

Sioux City, Ia.—A viaduct is to be constructed over Fourth St. this season. It is to be 200 ft. long, 80 ft. wide, with two 12-ft. walks on each side. The approaches will be about 800 ft. long. Plans are completed. Address Henry Wingeland, City Engineer.

Omaha, Neb.—Two viaducts will probably be constructed over the Union Pacific R. R. at Hamilton and Nelson Sts. this season. They will be about 60 ft. long.

WATER-WORKS.

NEW ENGLAND.

Millbridge, Me.—The following is from P. R. Smith:

Works are projected by the Millbridge Water Co., which proposes to bring water by gravity from a spring 5 miles distant; estimated cost, $25,000. The company is not fully organized, and may not be able to do anything for two years, unless it can arrange with parties controlling the present supply. Population, 500.

Hardwick, Vt.—A third village meeting to consider water-works was held on March 30.

Rutland, Vt.—Chappelle & Burke have made a preliminary report on the proposed new works. The estimated cost of the improvements is $61,397, not including land damages or right of way. The estimates are as follows: For a 5,000,000-gall. settling pond formed by excavation and by a dam across a ravine, 350 ft. long, $19,263; diverting dam of masonry across Mendon River, $1,980; 14-in. cast-iron conduit, 16,700 ft. long, estimated to require 760 tons of pipe and specials, $34,951; 5,000,000-gall. distributing reservoir, in excavation and embankment, $8,200. A popular vote in favor of the project must be taken before construction is started. The construction of the distributing reservoir may be postponed a year.

St. Johnsbury, Vt.—O. W. Orcutt informs us that the village expects to make extensive changes and repairs in its works this year.

Portsmouth, N. H.—J. H. Broughton is Chairman, and Calvin Page, Clerk, of the new Water Board.

Milford, Mass.—The Town Water Committee has voted not to take further action regarding the water company's proposition to erect a large stand-pipe.

New Bedford, Mass.—The Water Board, in its annual report, suggests that a separate distributing system be put in to supply water to the large consumers. No action has been taken on the suggestion.

Orange, Mass.—E. C. Fowler, Acting Town Clerk, informs us that bonds for works will probably be voted at a future town meeting. W. M. Wright is Secretary of the Water Committee. See ENGINEERING NEWS of last week.

Waltham, Mass.—The Water Commissioners have voted to employ a consulting engineer.

Webster, Mass.—At the coming town meeting a new water supply will be discussed. The present works are owned by H. N. Slater.

Newport, R. I.—It is reported that the Hyatt filtering plant is being enlarged.

Greenwich, Conn.—We are informed that a new 12-in. main is to be laid to secure an additional supply from a spring.

Norwich, Conn.—Some 10 and 6-in. cast-iron mains are to be laid. The pipe has been bought.

Rockville, Conn.—A majority of the Water Committee has reported against an attempt to purchase the company's works.

South Norwalk, Conn.—The contract for laying 22,000 ft. of 16, 1,565 ft. of 12, 1,660 ft. of 10 and 200 ft. of 4-in. pipe has been let to W. H. Morton, New York City, for $13,492.

Torrington, Conn.—The Torrington Water Co., it is reported, will build a dam to enlarge the storage of Whist Pond, in Goshen, and will lay a 12-in. main, 4,000 ft. long, evidently in a deep cut.

MIDDLE.

Afton, N. Y.—We are informed that works are being discussed.

Batavia, N. Y.—George Perrin, Clerk, informs us that a company is looking over the ground in connection with a project to supply the village with spring water. Preliminary surveys have been made. The village built works in 1875, which are described in the 1891 MANUAL OF AMERICAN WATER-WORKS. A $10,000 Gaskill pump was recently bought for the village works.

Hermon, N. Y.—The following is from C. O. Northrup:

The village proposes to let contracts about May 1 for works estimated to cost $8,000. The supply will be pumped from Spring Brook to a stand-pipe. Population, about 500.

The people have voted an additional sum of $2,500 for works, making a total of $10,000.

Hoboken, N. J.—The Hackensack Water Co. has just contracted for a 10,000,000-gall. high duty Worthington pumping engine.

Ilion, N. Y.—The following is from A. N. Russell, Secretary Water Commissioners:

Commissioners have been appointed to investigate the water supply question and report to the village trustees, after which a special election will be held to determine whether the village will build works. If certain springs prove capable of supplying the village, which has a population of 4,000, the supply will be by gravity. Otherwise wells will probably be sunk to water 75 ft. beneath the surface. No engineer has been employed. Population, 4,000.

Mount Vernon, N. Y.—The New York City Suburban Water Co. filed articles of incorporation March 27; capital stock, $1,500,000. Among the trustees are Charles B. Ludwig and John B. Gleason, of 72 and 115 Broadway, New York; Augustus F. Babcock, Brooklyn, and Leonard B. Leavy, Newark, N. J. The object of the company is said to be to supply Mount Vernon, which is now supplied by the New York & Mount Vernon Water Co., of which G. E. Taintor, 11 Wall St., New York, is President.

Rochester, N. Y.—The Pure Water Supply Co. has offered to deliver into the Mount Hope reservoir a daily supply of not less than 3,000,000 galls. of water from Bushnell's Basin for 10 cents per 1,000 galls. The company believes that 5,000,000 galls. a day can be furnished, and it offers to deliver it at the above price. J. Nelson Tubbs is Consulting Engineer for the company.

Schenectady, N. Y.—The Senate has passed a bill authorizing the city to provide an additional supply. Works estimated to cost $125,000 were recommended sometime since, and well on Van Dyck Island or the Mohawk River above the city were mentioned as sources.

Union, N. Y.—A citizens' meeting was recently held to discuss works. E. C. Meredith and Radcliff Park were prominent at the meeting. J. P. Herdic, Williamsport, Pa., is interested.

Ebensburg, Pa.—R. S. Thomas, Superintendent, informs us that a new pumping station is to be built about a mile north of the town. The kind of pumping machinery to be used is not yet known.

Lebanon, Pa.—The Council and Water Commissioners are considering plans and specifications for a new dam and storage reservoir. The plans were made by W. G. Burnside, City Engineer, and, it is reported, are for a 40,000,000 gall. reservoir.

McSherrystown and West Hanover, Pa.—R. K. Martin, Baltimore, Md., informs us that as yet works for these towns have only been talked of.

Newport, Pa. We are informed that C. A. Mahoney, 908 Spruce St., and C. A. Rutter, 925 Clinton St., Philadelphia, are among the incorporators of the Newport Water Co.; also that the capital stock is $1,000, of which $100 has been paid in.

Towanda, Pa.—We have received the following:

The property of the Towanda Water-Works Co. has passed into the hands of C. L. Goodhue, Springfield, Mass., who is now negotiating for pipe and other materials to be used in securing a new gravity supply from the Eilenberger Springs, distant some 16 miles from the city.

Westfield, Pa.—Bids for constructing works will be received by the Westfield Water Co. until May 1, as follows: For furnishing 48 ft. of 12, 3,023 ft. of 8, 5,452 ft. of 6, 17,783 ft. of 4-in. cast-iron pipe, 16,000 lbs. of special castings, 32 12 and 4 in. valves, 36 double nozzle fire hydrants, 27 valve boxes, for laying about 5 miles of pipe and an intake and for building a 500,000-gall. reservoir. J. H. Miller is President, and F. M. Leonard, Secretary, of the company.

SOUTHERN.

Newport News, Va.—Theodore Lirezey informs us that a light and water company with ample capital and water rights, has been organized.

Fairmont, W. Va.—The following is from W. S. Haymond, Recorder:

A popular vote on the issuance of $20,000 5% 30-year water bonds will be taken, probably sometime in April. Population, about 1,500.

New Berne, N. C.—The following is from G. E. Ladshaw:

Works are projected by the New Berne Water Co. at an estimated cost of $80,000. The supply as proposed will be pumped from a spring, two miles from the town, to a 200,000-gall. stand pipe. The pump will have a daily capacity of 1,000,000 galls. Cast-iron or Phippe cement-lined pipe will probably be used. Manufacturing interests will require a large amount of water. Address J. A. Bryan.

Dawson, Ga.—The American Pipe Co., Philadelphia, Pa., has bought a franchise, recently granted, and expects to put in works at once. Mayor Cheatham may be addressed.

Madison, Ga.—The following is from T. B. Baldwin:

A franchise will be granted to some company within 30 days. Population, 2,700.

Tennille, Ga.—It is reported that the town will let a contract for the construction of works to Hartford, Hebert & Co., Chattanooga. J. C. Hurman is Mayor.

Evergreen, Ala.—The following is from W. D. Atkinson:

Private works are projected estimated to cost $15,000. The supply will probably be pumped from wells, but nothing definite has yet been done. Population, 1,150.

Yazoo, Miss.—The following is from J. A. Jones, Engineer:

The Yazoo Improvement Co. let a contract for water-works to the Michigan Pipe Co., Bay City, on March 13. Water will be pumped from artesian wells to a stand-pipe; estimated cost, $100,000. The works are to be in operation June 20. D. B. Barnett is Secretary of the company. Population, 5,200.

Cleveland, Tenn.—A bill authorizing the issuance of $50,000 of bonds for works has passed the Senate.

Jasper, Tenn.—A water company was recently chartered to put in works here.

NORTH CENTRAL.

Defiance, O.—The company's stand-pipe burst March 29. Particulars are given elsewhere in this issue.

Lima, O.—Referring to the recent report on a new storage reservoir, R. H. Gamble, Engineer, has sent the following:

It has not yet been decided whether the reservoir will be built this year, but it cannot be postponed without danger of a water famine. The proposed reservoir would adjoin the present ones, would have an area of about 31 acres and a capacity, with 16 ft. of water, of 153,000,000 galls. Embankments would have to be constructed on but two sides. The estimated cost, exclusive of land, is $93,000.

Portsmouth, O.—Contracts for alterations and extensions of the mains, and for 9,000 ft. of lead services, including labor and material, have just been awarded to Snyder & Williams, Dayton.

Springfield, O.—The Trustees have asked the Council for authority to lay mains from 10 to 3 ins. in diameter on several streets.

Huntington, Ind.—The works have been successfully tested.

Noblesville, Ind.—It is reported that the Council will grant a franchise for works, the people having recently voted in favor of works.

Fowlerville, Mich.—It is reported that a direct pumping system of works will be built.

Mecomb, Ill.—On April 1 the people voted on the issuance of $25,000 of bonds for works.

Minier, Ill.—C. L. Moon informs us that the village intends to put in small fire protection works at an estimated cost of $800 or $1,000. Population, 800.

NORTHWESTERN.

Blooming Prairie, Minn.—P. Prahm, Recorder, informs us that the water-works question will be decided by popular vote April 7.

Duluth, Minn.—There is some talk, merely, regarding works to be owned by the city, to be obtained either by constructing a new or buying the company's plant.

Willmar, Minn.—The following is from H. J. Ramsett, Recorder:

The contract for works was let March 27 to Harrison & Hawley, St. Paul, Minn., for $17,853. A steel tank or stand-pipe may be substituted for the proposed wooden tank. The supply will be from wells about 110 ft. deep, four of which will be sunk at first, and two added if necessary. These will be sunk by the village, and are not included in the contract. There will be nearly three miles of mains.

Winona, Minn.—The following is from J. B. Fellows, City Engineer and Water Commissioner:

The city proposes to issue $50,000 of water bonds, put in a 5,000,000-gall. pump, lay a new force main and two miles of distributing mains.

Arapahoe, Neb.—A canvass is being made to ascertain the general opinion regarding the establishment of works.

Deadwood, S. Dak.—T. J. Grier, Superintendent, informs us that the laying of about one mile of new 6 and 4-in. mains is under consideration.

SOUTHWESTERN.

Kansas City, Mo.—It is reported that the company has named a price for which it would sell to the city that part of its property which is located in Missouri, also that an election has been called for April 28 to vote on the issuance of bonds for works.

Cisco, Tex.—The following is from J. S. Thatcher, of Dallas, Engineer:

A contract for works to be owned by a company has been let to Z. T. Williams, Ft. Worth. There will be a 50,000,000-gall. reservoir, a 500,000-gall pump, 12 × 60-ft. stand-pipe, 3½ miles of cast-iron mains and 12 hydrants. Estimated cost, $30,000.

Crockett, Tex.—A. A. Aldrich has sent the following:

The water-works project has not yet taken definite shape, but a canvass among the business men of the town shows that they favor works, and will subscribe toward them. A reservoir will probably be used, and it is likely that the works will be built by a company. Population, 1,800.

Laredo, Tex.—The following is from the Laredo Water Co.:

The company proposes to build an 8,500,000 gall. reservoir; to replace 18,000 ft. of 4-in. mains with 6-in.; to lay 1,980 ft. 16-in., 600 ft. of 14-in., 7,200 ft. of 12 in., 2,400 ft. of 10-in., and about 10,000 ft. of 6-in pipe.

Galveston, Tex.—The following is from D. J. Buckley, City Clerk:

The Council has applied for an amendment to the city charter authorizing the issuance of $1,240,000 5% 40-year bonds. Of this sum $900,000, if as much is necessary, is to be used for obtaining a supply of pure water. The amendment is likely to pass. Work will soon be started on a 3,000-ft. artesian well. The price is $75,000, with no pay unless the contractors reach a depth of 3,000 ft. with 6-in. pipe. Of course the well will not be carried to the full depth if water is found nearer the surface.

Llano, Tex.—W. W. Knowles & Son inform us that they will enlarge their water-works soon.

Terrell, Tex.—The Ice, Light & Water Co. has been incorporated; capital, $50,000.

Tyler, Tex.—B. W. Rowland, Secretary, informs us that the company is arranging for another pumping station, to be located on Indian Creek; cost, about $30,000.

Wichita Falls, Tex.—It is reported that the construction of works will soon be started. D. A. Chappell, Trinidad, Col., has the franchise.

Denver, Col.—C. H. Venner & Co., New York and Boston, offer for sale $4,000,000 of 5% 20-year bonds of the Denver City Water-Works Co.

PACIFIC.

Aberdeen, Wash.—The city wishes bids until April 15 for the construction of works, the bids to be based upon plans and specifications to be furnished by the bidder. J. H. White is City Clerk.

Mount Tabor, Ore.—The following is from J. L. Ivers, Secretary:

Works are under construction by the Mt. Tabor Villa Water Co.; estimated cost, $5,000. Water will be pumped from a 225 ft. well to a 30,000-gall. tank. The place has been without water. Population, 300.

San Bernardino, Cal.—Bids will be received until April 21 for furnishing and laying 2,112 ft. of 4-in. Kalamein pipe; also for furnishing and setting three double-nozzle hydrants and four valves. F. C. Finkle is City Engineer.

Santa Ana, Cal.—The Baker Iron Works, Los Angeles, has been awarded the contract for works, as advertised recently in this journal. The price was about $58,000.

Midway, Utah.—A. I. Alexander is Chairman, and John Watkins, another member of a recently appointed water committee. It is thought that works can be built for $5,000. The supply will probably be from springs.

CANADA.

Halifax, N. S.—Improvements to the works are to be made under the direction of City Engineer E. H. Keating.

Amherstburg, Ont.—Bids for works were received until April 1.

Leamington, Ont.—Bids for works are wanted by the town until April 10. Bids are to be based on plans made by Alexander Baird. Specifications can be secured at $3 a set from J. F. McKay, Town Clerk.

Lindsay, Ont.—Bids are wanted by the town until April 10 for the construction of works to be owned by the town. Bids are also wanted from companies stating hydrant rental and schedule of private water rates. The town requires 6¼ miles of 12 to 6-in. pipe, 67 hydrants and pumps, with a guaranteed daily capacity of 1,500,000 galls., giving 100 lbs. pressure. Fred Knowlson is Town Clerk.

ARTESIAN WELLS.

O'Neil, Neb.—The sinking of a well has just been started.

Dickey Co., N. D.—Charles Ackley, City Auditor of Ellendale, informs us that two wells are now being sunk in the county, and that contracts for four more have been let. If the wells are a success many more will be sunk to secure water for irrigation.

IRRIGATION.

Medford, Ore.—The Rogue River Valley Water Co. proposes to build storage reservoirs and construct canals to be used for irrigating purposes. The company has a capital stock of $125,000, and was organized by H. Klippel, J. A. Lee and others.

Allessandro, Cal.—It is reported that surveys are being made by the Bear Valley Irrigation Co. with a view of irrigating land here by means of water brought through a pipe line from Whitewater River and Snow Creek.

Garvanza, Cal.—The citizens of Garvanza and Highland Park talk of organizing an irrigation district. J. H. Spires, A. Green and Ralph Rogers were recently appointed a committee on information.

Grapeland, Cal.—The Grapeland Irrigation District recently offered $200,000 for sale. J. D. Ousterhout is President and E. T. Myers is Secretary.

New Companies.—The following companies are reported as recently incorporated, the figures representing capital stock and the names incorporators: Lane County Irrigation Co., Healy, Kan., $20,000, Irondale Ditch & Reservoir Co., Denver, Col., $30,000, to operate Cactus and other ditches. Lebanon & Santiam Canal Co., Lebanon, Ore., $12,000; C. H. Ralston, J. A. Beard, Chewaucon River Irrigation Co., Paisley, Ore.; $25,000; George Conn, William Carle, De Garno and North Warner Irrigation Cos., of Plush, Ore.; each with a capital of $100,000, and with Thomas Anderson, W. A. Chalton and others as incorporators. Also Snider Creek Irrigation Co., of Plush, Ore., same incorporators as above, with addition of D. R. Jones. Buck Creek Irrigation Ditch Co., Silver Lake, Ore.; $5,000; J. M. Small, A. L. Hazelton. Also Silver Lake Canal Co., Silver Lake; $50,000; G. H. Small, W. C. Martin. Deep Creek Irrigation & Water & Canal Co., South Warner, Ore.; $10,000; R. E. McCounnaughy, T. A. Handeas. Umatilla Irrigation Co., Portland, Ore.; $10,000. Locust Grove Ditch Co., Visalia, Cal., $2,500.

SEWERAGE AND MUNICIPAL.

Sewers.—***Manchester, N. H.***—Work on the sewers will be commenced as soon as the frost is out of the ground.

Newark, N. J.—A new commission is to be appointed to assess the benefits for the intercepting sewer.

Canton, Md.—The Canton Improvement Association has been organized to provide for sewerage and other improvements. Secretary, F. Beckerfield.

Indianapolis, Ind.—The cost of the proposed drainage ditch for the northeast district is estimated by the City Engineer at about $26,000. It will be 300 ft. long, 20 ft. wide at the bottom, with side slopes of 1½ to 1. Excavation is estimated at 30 cts. per cu. yd.; railway trestling, $7 to $12 per lin. ft.; frame highway bridges, $12 per lin. ft.

Anderson, Ind.—The City Council has adopted a general plan for a system of sewerage.

Chicago, Ill.—The Drainage Canal trustees propose to amend the law so that the canal may be only 10 ft. deep, instead of 14 to 18 ft. It is estimated that this will effect a saving of $25,000,000. The people of the Desplaines valley are moving for the repeal of the drainage act. Work on the city sewer extensions has been commenced; they will aggregate about 76,000 ft.

Detroit, Mich.—The Sewer Committee proposes to expend $200,000 on sewers.

Duluth, Minn.—Mr. W. B. Fuller, City Engineer, states that $300,000 will be expended this year on sewers

and streets. The work will include 5 miles of sanitary sewers, 3 miles of storm sewers, 5 miles of street grading and 1 mile of block paving.

Winona, Minn.—Mr. U H. Broughton has been engaged to prepare plans for sewerage by the Shone system for a certain district of the city.

Muscatine, Ia.—The city attorney has drafted an ordinance providing for a system of sewerage.

Streets.—*Albany, N. Y.*—An assembly bill has been introduced providing for the opening, laying out, monumenting and fixing the grades of streets. The work is to be under the direction of the city engineer, with two assistants at salaries of $1,800 and $1,600 per annum.

Baltimore, Md.—The Court of Appeals has decided that under the act of 1874 the city may provide by ordinance for making assessments to pay the expense of paving and repaving its streets, lanes and alleys, and for collecting those assessments from the parties charged therewith by appropriate proceedings in the courts.

Cincinnati, O.—The Board of Public Improvements has approved resolutions asking the legislature to authorize the expenditure of $300,000 annually for 3 years on street improvements.

Carthage, O.—Cement sidewalks are to be laid, and proposals will be opened April 10. For particulars address A. L. Tosso.

Chicago, Ill.—The gas, electric light and telephone companies, and the fire, water and sewer departments have been notified by the Superintendent of Streets to finish all underground work before the street department begins its work for the spring.

Winona, Minn.—The Paving Committee will recommend the adoption of cedar block paving.

Street Cleaning.—*Boston, Mass.*—The Street Department is trying the patrol system on certain streets, and has supplied the men with light hand-carts similar to those recently adopted in New York. The Flanagan odorless dump-cart is also being tried.

Bonds.—City improvement bonds are to be issued as follows: Alliance, O., $30,000 for sewers, $20,000 for streets; vote to be taken shortly. Leesburg, O., $2,500 for streets, etc. Ashland O., $100,000 for general improvement. Big Stone Gap, Va., $50,000 for sewers, etc.; vote to be taken April 9. Charlottesville, Va., $100,000 for sewers. Staunton, Va., $22,000 for Belgian block paving; address the Street Committee. Bristol, Tenn., $200,000 for street improvements. Knoxville, Tenn., $500,000 for sewerage, etc.; vote to be taken June 18. Macon, Ga., $100,000 for sewers; vote to be taken April 24. Memphis, Tenn., $1,000,000 for street paving.

Garbage Disposal.—At Buffalo, N. Y., an experimental cremator has been built by Mr. James Boland, and given a test for the street committee. The fire is of coke and a forced draft is used. At Toronto, Ont., experiments are to be made with garbage cremation. Other methods will also be considered by the council.

Lighting.—*Baltimore, Md.*—The Consolidated Gas Co. has made a proposition to supply gas for street lamps at $31 per lamp per year, and gasoline at $16 per lamp per year, including maintenance and repairs.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are reported as probable in the following places: Saranac Lake, N. Y.; Sanborn, Ia., address D. R. Phelps; Phenix City, Ga.; Grand Tower, Ill; Carbondale, Ill.; Creal Springs, Ill.; Washington, Ga.; Martinsburg, Va., address T. W. McSherry; Greenville, Tenn., address the Greenville Electric Light Co.; Parkersburg, W. Va; Belmont, N. Y.; Cuero, Tex.; Martinsville, Ind., address J. H Henry; Highlands, Colo., address F. B. Arbuckle; Newbury, S. C; Roseburg, Ore.; Nashville, Tenn., address J. W. Braid; Aberdeen, S. D., address B. F. Johnson; Mayville, N. Y., address L. Bixby; South Manchester, Conn., address F. E. Watkins; South Berwick, Me.; Austell, Ga.; Haverstraw, N. Y.; Noblesville, Ind.

Washington, Ga.—Bids are wanted by B. S. Irvin for constructing a station with a capacity of 15 arc and 60 incandescent lights.

Middlesborough, Ky.—It is reported that the Middlesborough Electric Light, Heat & Power Co. will erect a new station with a capacity of 3,000 incandescent and 800 arc lights.

Crawfordsville, Ind.—The Western Electric Co. has received a $10,600 contract for erecting a plant for the city. It is to have a capacity of 350 incandescent and 80 arc lamps, the latter of 2,000 c. p. The city will provide the buildings and engines.

Mt. Carmel, Ill.—The city will be lit by thirty 3,000 c. p. lights, burning all night, at $60 each annually.

New Companies.—Electric Manufacturing & Gas Engine Co., Greenbush Heights, N. Y.; capital stock $75,000; incorporators, E. N. McKinney, of Albany; G. H. Ennis, of Troy; R. J. and J. H. Pratt, of East Greenbush. Telegraphic Novelty Co., Jersey City, N. J.; capital stock $45,000; incorporators, W. P. Phillips and F. N. Bassett, of New York; T. R. Taltavall, of Montclair, N. J. Washington City Developing Co., Elizabeth, N. J.; capital stock, $1,000,000; incorporators, F. H. Davis, A. K. Van Deventer, S. A. Van Derveer; object, construction of railways. Bala & Merion Electric Light Co., Morristown, Pa.; capital stock, $28,000; directors, C. E. Hartshorne, L. Godfrey and others. Millersburg, Pa., Electric Light, Heat & Power Co.; capital stock, $3,000; directors, J. Koppenheffer, N. C. Freck, R. B. Brandenhaugh.

CONTRACTING.

Dredging.—The following proposals for dredging have been received by Major Livermore, U. S. Engineer Office, Newport, R. I. In Providence river and harbor: H. J. Du Bois' Sons, New York, N. Y., 9 cts. per cu. yd. in scows; Atlantic Dredging Co., New York, N. Y., 9 cts. In Pawtucket River: E. M. Payn, Albany, N. Y., 31 cts., $15 per cu. yd. for removing large bowlders; Elijah Brainard, New York, N. Y., 32¼ cts., or 29½ cts. if work is commenced Sept. 1 and completed June 30, 1892, $11.75 per cu. yd. for removing bowlders.

The following proposals for dredging in Maryland have been received by Gen. W. T. Smith, U. S. Engineer Office, Wilmington, Del. The prices are cts. per cu. yd. in scow:

	Elk River.	Northeast River.	Fairlee Creek.
C. T. Caler, Norfolk, Va.	12½	13½	16
F. C. Somers, Camden, N. J.	15.4	17	15.4
Atlas Dredging Co., Philadelphia, Pa	18	20	17
American Dredging Co., Philadelphia, Pa.	19	16	18
National Dredging Co., Wilmington, Del.	14	..	20
Baltimore Dredging Co.	16⅞	18½	27.3

Jetties.—The following proposals for constructing riprap jetties at Patchogue River and Brown's Creek, Long Island, have been received by Col. D. C. Houston, U. S. Engineer Office, New York, N. Y.: E. Bailey & Sons, Patchogue, N. Y., $2.80 per ton, $16,800; Wm. H. Molthrop & Co., New London, Conn., $2.90, $17,400; Wm. H. Morton, New York, N. Y., $5.99, $35,940.

Galveston, Tex.—The lowest bid for sandstone jetties for the harbor improvements, received March 30 at the U. S. Engineer Office, was from B. L. Lantry & Sons, Strong City, Kan., $2,849,064; for granite jetties, Ricker, Lee & Co., of Galveston, had the lowest bid, $4,553,940.

Sewers.—*Superior, Wis.*—The contract for sewers has been awarded by Mr. E. B. Banks, City Engineer, to G. J. Anderson, of West Superior: 10 ft. 4 in. and 10 ft. 2 in. brick sewers, in earth, $19.94½ and $18.94½ per ft.; in masonry, $22.40 and $22.36½ per ft.; on piles, $26.94½ and $25.90½ per ft.; manholes and catch-basins, $60 each; outlet, including 10 ft. of 10 ft. 4 in. sewer, $100.92; total bid, $60,856.

Coal.—*Cincinnati, O.*—A contract for furnishing coal for the year to the water-works has been awarded to the Winifred Coal Co., of West Virginia, at $2.27 per ton.

Steel Pipe.—*Riverside, Cal.*—The East Riverside Irrigation District has received 2 bids for 30 in. steel conduit, including laying, joints, valves, etc.: Silver Gate Mfg. Co., San Diego, Cal., $2.42 to $3.52 per ft.; California Bridge Co., San Francisco, Cal., $2.27 to $2.85.

Canal.—*Tuscola, Ill.*—A contract for a canal 7 miles long has been awarded by the Drainage Commissioners to J. E. Rogers, at 8½ cts. per cu. yd. The cost will be about $10,000. Other contracts are to be let.

Cement.—*New York, N. Y.*—The Department of Docks has awarded the contract for 1,500 bbls. of quick setting Portland cement to Baetier & Meyerstein, at $2.43 per bbl.

PROPOSALS OPEN.

Water-Works.—*Aberdeen, Wash.*—Plans, specifications and contract. J. H. White, City Clerk. April 15.

Westfield, Pa.—Pipe, hydrants, trenching, 500,000-gall. reservoir. J. H. Millar, President, Westfield Water Co. May 1.

Blow-Off.—*New York, N. Y.*—At shaft No. 24, New Croton Aqueduct. The Aqueduct Commissioners, 280 Broadway. April 8.

Sewers.—*New York, N. Y.*—Department of Public Works, 31 Chambers St. April 13.

Trenton, N. J.—Circular and oval brick sewers, manholes, etc. J. C. Owens, City Clerk April 10.

Street Work.—*Avondale, O.*—Artificial stone sidewalks. W. E. Wynne, Corporation Clerk. April 11.

Carthage, O.—Cement sidewalks. A. L. Tosso, Secretary of Street Committee. April 10.

Sewer Pipe.—*Terre Haute, Ind.*—About 3,350 ft. of 24-in. fire-clay pipe, and 1,000,000 front and foundation brick. J. B. Patten, Warden of Indiana State Prison South. May 12.

Wilmington, Del.—About 20,000 ft. of various sizes. T. C. Hatton, Engineer. April 7.

Dredging.—About 100,000 cu. yds., in harbor at Charlotte, N. Y. Capt. D. C. Kingman, U. S. Engineer Office, Oswego, N. Y. April 20.

Jail.—*Helena, Mont.*—J. S. Tooker, Clerk of Commissioners. April 23.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Schenectady Locomotive Works, o Schenectady, N. Y., have delivered 2 engines to the Chicago & Northwestern, and 1 to the Atchison, Topeka & Santa Fé. The Manchester Locomotive Works, of Manchester, N. H., are building 3 switch engines for the Boston & Maine, and 2 engines for the New York, Providence & Boston. The Baldwin Locomotive Works, of Philadelphia, Pa., have built 2 engines for the Fairhaven & Southern, and 4 for the Lehigh Valley. The Rhode Island Locomotive Works, of Providence, R. I., have delivered 5 eight-wheel engines to the New York, New Haven & Hartford, and 2 mogul engines to the Fort Worth & Rio Grande. The Michigan Central will build 8 engines at its works, at Jackson, Mich., this season. Locomotives are wanted by W. E. Croom, Maxton, N. C., and the Dunellon Phosphate Co., of Madison, Fla

Cars.—The United States Rolling Stock Co. has leased to the Chicago & Atlantic 1,000 box cars, 400 gondola cars and 100 stock cars. The Barney & Smith Mfg. Co., of Dayton, O., has an order for 6 passenger cars for the Pittsburg, Shenango & Lake Erie. The Madison Car Co., of Madison, Ill., has its works nearly completed. They will include an erecting shop 160 × 900 ft.; wood working shop, 160 × 480 ft., and foundry 145 × 700 ft. Cars are wanted by the Dunellon Phosphate Co., of Madison, Fla.

Railway Buildings.—The Michigan Central will extend its locomotive works at Jackson, Mich. A new union station has been built at Louisville, Ky. Contracts have been let for a union station at Terre Haute, Ind., to cost about $120,000.

Signals.—An electric signal system has been patented by H. A. Johnson and J. A. Carlton, of Atlanta, Ga., in which the trains automatically set a danger signal on entering each section and release it on passing to the next section The Bowne Pneumatic Signal Co. has one of its gong and target signals at a street crossing at Baltimore, on the Baltimore & Ohio.

Water Meters.—The Thomson Meter Co., of New York, N. Y., has a testimonial from the Water Registrar at Fitchburg, Mass., of a test made Nov. 15, 1890, of a meter with a ⅜-in. jet, which had passed 1,090,526 cu. ft. of water. The test showed no error in the meter after this service.

Walking Machine.—A correspondent states that Thomas Hill, of Bridgeport, O., is at work on a steam walking machine with "shoes" instead of wheels, for drawing plows over soft soil.

Paving Bricks.—A paving brick company is being organized by Potts & Carmack, of Huntington, W. Va. Capital stock, $100,000.

Cement.—The American Portland cement mills at Cumberland, Md., that were burned October, 1890, are being rebuilt.

Companies.—Hallowes Car Axle Box Co., of Jersey City, N. J.; incorporators, C. H. Koyl, Wm. F. Pascoe and O. W. Markle, all of Easton, Pa.; capital stock, $100,000. Excelsior Car Roof Co., of East St. Louis, Ill.; incorporators, C. M. Jennings, J. S. Berthold and Geo. S. Hoke; capital stock, $75,000. Union Rubber Cement Co., of Newark, N. J.; incorporators, F. H Crary, of East Orange, C. C. Thomas and George S. Mallory, of Jersey City; capital stock, $6,000. Electrical Mfg. & Gas Engine Co., of Greenbush, N. Y.; incorporators, E. N. McKinney, of Albany, George H. Ennis, of Troy, R. J. Pratt, of East Greenbush; capital stock, $75,000. Columbia Car Coupler Co., of Chicago, Ill., to manufacture car couplers, metal ties, etc.; capital stock, $300,000. American Construction Co., of Detroit, Mich.; W. A. Eldridge, W. J Woodworth and John S. Ellis; engineer, Wm. Z. McDonald, Columbus, O.; capital stock, $200,000.

Metal Market Prices.—*Rails.*—New York: $30.75 to $31; old rails, $21 to $21.50 for iron and $17.25 for steel. Pittsburg: $26.50 to $27; old rails, $24 to $24.50 for iron and $17.50 for steel. Chicago: $31; old rails, $23.25 for iron and $17 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.8 cts.; spikes, $1.9 to $1.95; track bolts, 2.65 to 2.75 cts. with square, and 3.1 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.95 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2.1 cts.; track bolts, 2.85 to 2.95 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $16. Pittsburg: $14.75 to $17. Chicago: $14.50 to $16.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.35 to 4.4 cts. Chicago, 4.15 cts. St. Louis, 4.1 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 to 2.1 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.05 to 2.25 cts.; steel plates, 2.05 to 2.15 cts. for tank, 2.35 to 2.6 cts. for shell, 2.6 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 cts.; tees, 2.85 cts.; universal iron mill plates, 2.1 cts.; sheared steel bridge plates, 2.3 to 2.35 cts.; refined bars, 1.9 cts.; steel plates, 2.2 cts. for tank, 2.55 cts. for shell, 2.75 cts. for flange, 4.25 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.5 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; csheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.65 to 2.75 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.